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ABSTRACT

This collection provides a number of perspectives on the central role that language plays in reading comprehension. Following an introduction by the editor, entitled "Attention and Individual Differences in Comprehension," the following papers are presented: (1) "The Line of Sight Approach," by Norman H. Mackworth; (2) "The Information Processing Approach," by D. L. Fisher and M. S. Smith; (3) "Language Development: Universal Aspects and Individual Variation," by Paula Menyuk; (4) "Developmental Psycholinguistics: Implications for Reading Research," by Stanley F. Wanat; (5) "Communication and Cognitive Style: A Clinical Perspective," by Robert W. Goldberg; (6) "The Role of Intention in Reading and Thinking," by Russell G. Stauffer; and (7) "Efficiency in Beginning Reading: Possible Effects on Later Comprehension," by Kenneth J. Smith. The first two papers consider different approaches to the analysis of reading comprehension difficulties. The third and fourth papers deal with commonalities and individual differences identified by research on language learning and some implications of that research for reading. The fifth and sixth papers explore cognitive style factors in communication and comprehension. The last paper discusses the types of linguistic units attended to in beginning reading. A list of references concludes the book. (Author/RM)

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LINGUISTICS AND READING SERIES: 2

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Language and Reading Comprehension

edited by Stanley F. Wanat

Roger W. Shuy, General Series Editor

CENTER FOR APPLIED LINGUISTICS

2

LANGUAGE AND READING COMPREHENSION

Stanley F. Wanat, Editor

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Preface

The important relationship of linguistics to reading has long been recognized but seldom has it been adequately exploited. Many linguists feel that when people read, they call on what they know about language form and use in ways which we, as yet, little understand. Many reading specialists, likewise, feel that reading is some type of language processing operation in which the language takes the form of print on the page. Although both the fields of linguistics and reading are concerned with meaning, there has been little sharing of ideas across the fields. A great deal of mutual focus, in the past, has been on letter-sound correspondence. This focus has led many teachers to consider the contribution of linguistics to be little more than phonology. Some reading people, in fact, erroneously think of this contribution as "the linguistic approach."

As the title indicates, this series is dedicated to the bringing together of linguistics and reading. It is intended to present both technical and practical matters which contribute to the comprehension of the printed page. The various issues in the series will be theme oriented, centering around a specific concept or approach for which both the fields of linguistics and reading can benefit. The ultimate goal of the series is to open insights about reading to linguists and insights about linguistics to reading specialists.

Roger W. Shuy
March 1977

Introduction: Attention and Individual Differences in Comprehension

Half a dozen years ago, a massive review of the reading research literature concluded that "the reading problem" in the U.S. is not explainable in terms of the ability to learn--or the inability to learn--grapheme-phoneme correspondences. Rather, it has to do with the difficulties that people have in comprehending spoken, as well as written, messages (Corder, 1971). This conclusion is, of course, completely consistent with the obvious, but oftentimes overlooked observation that the reader's comprehension of *written* language depends upon the reader's comprehension of *language*.

Understanding of the processes involved in reading comprehension, and understanding of breakdowns and failures in reading comprehension processes, need to build upon an understanding of how spoken language is comprehended. There is a common core of linguistic knowledge, skills, and strategies underlying an individual's reading, listening, speaking, and writing. Inquiry into language structure, language use, and language variation is necessary to improve current procedures for diagnosing and remediating reading comprehension problems. There are three strong arguments for coordinated inquiry on language and reading comprehension. First, there is the evidence cited above that, at the heart of "the reading problem" are difficulties in comprehending spoken, as well as written, messages (Corder, 1971). Second, for purposes of diagnosis and remediation, it is important to know the extent to which an individual's reading comprehension difficulties are due to problems in dealing with written language specifically, or problems in dealing with language, whether spoken or written (Sticht and Beck, 1976). Third, the evidence of transfer of training from listening skills to reading skills indicates that skills necessary for reading comprehension can be effectively and efficiently taught as *listening comprehension* skills; once taught as listening skills, these *language comprehension* skills are automatically accessible to the learner in his *reading comprehension* activities (Sticht and James, 1977).

The papers in this collection provide a number of perspectives on the central role that language plays in reading comprehension. Two themes emerge as crucial to deeper understanding of reading comprehension: *the role of attention*, and *the role of individual differences*. Research in reading comprehension, like research in cognitive psychology, has been far more concerned with individual commonalities and far less with individual differences in the linguistic, cognitive, perceptual, and affective factors that may have a determining effect on an individual's reading comprehension. Arguments advanced in support of the study of linguistic variation also apply to the study of variation with respect to reading comprehension.

This collection points to the role of attention as an important focal point for further inquiry into reading comprehension. What the reader attends to, and how he allocates his attention in reading determine the accuracy, depth, and efficiency of his comprehension. Very recently, there has been a significant convergence by researchers from different fields on attention as a major factor in reading comprehension, reading development, and reading disability. This introduction provides a brief discussion of attention as a major factor in reading comprehension, and comments on the various types of linguistic structures

attended to by the reader as he extracts meaning from written language. Following that, the contributions that each of the papers in this collection makes to the study of reading comprehension are briefly noted.

Attention is a vital control mechanism in our everyday information processing activities. We may drive right past a stop sign because we were so engrossed in conversation with our passengers that we stopped paying attention to our driving. While at a lecture, we may "tune out" or stop paying attention to the speaker, and then be startled back to attention by the sound of the audience applauding. Or we may suddenly realize that we have "read" the last few pages in a book without "paying attention," and consequently, we have to reread them.

Students in some classrooms spend about twice as much time paying attention to the teacher as do students in other classrooms; the amount of time that students in "slow" reading groups spend attending to the reading task may be far less than for students in "fast" reading groups (McDermott, 1976, 1977). The amount of time that students spend attending to an instructional task is an important variable determining whether or not they learn (Wanat, 1975). A study exploring the widely held view that, in the U.S., girls are better readers than boys, suggested that the sex difference favoring girls frequently found in reading achievement seems to be mediated by an attentional variable (Samuels and Turnure, 1974). Thus, differences in the allocation of attention in the classroom seem to underlie sex differences in reading achievement. The observations of McDermott, Wanat, and Samuels and Turnure suggest that, at a "macro" level, differences in the allocation of attention may be related to performance differences in classroom activities such as reading.

One remedial reading program worked at training problem readers to direct their attention to various linguistic units serving as accesses to comprehension "by making attention necessary to successfully complete the task, the experimental *Ss* were 'trained' to attend (Heiman, Fisher, and Ross, 1973)." This supplementary attention training averaged a *total* of four and one-quarter hours per person, spread over a seven-week period. At the end of the program, the group that received the four and one-quarter-hour-long attention-training program was more than a full year ahead of the matched control group. Thus, attention was shown to be an important force in reading development. A comparison of the effectiveness of different strategies for teaching children to recognize new words concluded that "the results of the present study support Samuels' focal attention hypothesis that to facilitate acquisition of word recognition responses, visual attention must be focused on the printed word [unlike the case of a contrasting instructional strategy, in which other visual stimuli competed with the printed word for the reader's visual attention]....If we apply the focal attention construct to reading, high IQ children, who also tend to be the better readers, seem to learn at a faster rate because they focus their attention on the relevant attributes of the stimulus sooner than the low IQ children (Singer, Samuels, and Spiroff, 1974)."

There have also been "micro" analyses of attention, carried out in laboratory settings. Such studies have shown that the reader's allocation of visual attention to a particular linguistic structure is related to factors such as the immediate constituent analysis of the sentence, and the predictability of that structure from its linguistic context (Wanat, 1968, 1972, 1976A, 1976B). In their enumeration of general principles about skilled reading, Gibson and Levin (1975) identify selective attention to features of words as a first principle. Also, "the general principle of differential allocation of attention to specific systems with automatization of others applies to many specific types of reading (Geyer and Kilers, 1974)." Furthermore, clinical and experimental studies suggest that a lag in the development of selective attention may be a common factor underlying a range of reading disorders and learning disabilities (Ross, 1976). Finally, Shuy (1977) has proposed a framework for a developmental model of reading in which the reader's allocation of attention to different kinds of

linguistic structures describes different stages in reading development, different types of reading tasks, and the effects of different instructional approaches. (Shuy'a apt term for these structures is *language accesses to reading*. He points out that most of these language accesses to reading are the same language accesses that one uses to comprehend spoken language, and that one would also use in learning a second language.) Thus, evidence accumulating from a number of fields strongly indicates that attention is a major factor in reading comprehension, reading development, and reading disability. The types of linguistic units attended to by the reader are determined by the nature of the reading task, by how far advanced his reading skills are, and by the nature of the instructional program through which he was taught to read. Consequently, it should not be surprising that there is evidence showing that different kinds of linguistic units each play a role as readers extract meaning from written language.

What are some characteristics of the various types of linguistic structures attended to by readers as they extract meaning from written language? These structures are letters, grapheme-phoneme correspondences, word parts, spelling patterns, syllables, morphemes, words, phrases, clauses, sentences, and text.

Letters. Many children begin learning to read through programs in which attention is focused almost exclusively on letter units. Whether or not *mature* readers process individual letters in most reading tasks is, surprisingly, still being debated. It has been argued that mature readers comprehend text at rates that are too fast to permit the processing of individual letters (Goodman, 1976C); however, it has also been argued that reading, even for the highly fluent reader, is a letter-by-letter process (Gough, 1976). Research on visual attention in reading provides support for this latter view. Research (McConkie and Rayner, 1976; Rayner, 1975; Rayner and McConkie, 1974) conducted on the size characteristics of the visual display from which the reader picks up information when reading a text addressed the following question: How large is the area from which information can be picked up during a single eye fixation while reading? According to McConkie and Rayner, the actual identification of word *meanings* seems to occur only for words beginning no farther than four to six letter spaces to the right of the fixation point.

What do these data have to contribute to the debate about whether or not individual letters are processed in mature reading? If the mature reader can pick up the information necessary for word meaning identification as far to the left of his fixation point as he can to the right (McConkie and Rayner say that this is four to six letter spaces; we will use the average of five), then he should be able to pick up meaning identification information from 10 letter spaces (five to the left plus five to the right) per fixation. Since the mature reader averages about four fixations per second (Geyer and Kilers, 1974), the reader can pick up word meanings from 40 letter spaces per second. In a minute, the reader can pick up meaning information from 60 times this number of letter spaces, or from 2400 letter spaces. Using an estimate of seven letter spaces per word, a reading speed of approximately 340 wpm is arrived at by dividing seven letter spaces per word into 2400 letter spaces per minute. The optimal rate for comprehending text has been found to be about 250 to 300 wpm (Sticht and Beck, 1976). Since 340 wpm is a very respectable reading rate for an adult, the argument that the mature reader *can* process and *does* process--but not always--letter by letter must be taken seriously. Thus, letters are language accesses to reading that are attended to by beginning and mature readers.

Grapheme-phoneme correspondences. While letters are important language accesses to reading, they are really just part of a language access to reading, since letters stand for sounds. The reader, whether beginning or mature, processes letters so as to get to the sounds that make up the meaningful units of his spoken language. The importance of grapheme-phoneme correspondences as a language access in mature reading comprehension is still being debated. On the one

hand, there is the conclusion of the ETS-Berkeley literature review (Corder, 1971) mentioned earlier that the U.S. reading problem is not explainable in terms of grapheme-phoneme correspondences, and there is the view that the mature reader goes directly from print to meaning (F. Smith, 1973). On the other hand, there have been detailed diagnostic analyses of reading comprehension difficulties showing that part of the problem, at least for some readers, involves grapheme-phoneme correspondences (Sticht and Beck, 1976), and there has been research showing that the view that mature readers go directly from print to meaning holds for special situations unlike most reading comprehension tasks (Kleiman, 1975).

Word parts. Children differentially attend to word parts in reading (Weber, 1970A, 1970B). A word's beginning letter is the most important cue to recognition for children learning how to read, the last letter is next most informative, the middle of the word is the third most relevant cue. Word shape is the least-used cue for the sample of children tested (Marchbanks and Levin, 1965). When this study of cue-type attended to was extended to "disadvantaged" kindergartners with no reading training, it was found that no cue was prefered; when adults were tested, half used a decoding-to-speech strategy, while the other half reported they tried to match by overall word shape--strategies not employed by the sample of children (Blumberg, Williams, and Williams, 1969). The differences in type of cue used by the three age groups indicate that the language accesses attended to are determined in part by one's reading developmental stage. The finding that half the adults depended primarily on one strategy, while the other half depended primarily on another strategy indicates important individual differences in attentional, and other information extraction processes in reading.

Spelling patterns. Deaf subjects are more successful in reading pronounceable than unpronounceable letter sequences (Gibson, Shurcliff, and Yonas, 1970). Since the subjects were either congenitally deaf or had become deaf very early in life, they could not be using grapheme-phoneme correspondences to perform better on some of these letter strings. The reader (hearing as well as deaf) may be utilizing orthographic constraints in addition to, or instead of, grapheme-phoneme correspondences. A spelling pattern is a sequence of letters that maps invariantly to a sequence of sounds. This property makes spelling patterns important functional units in mature reading and in reading acquisition.

Syllables. There is evidence that syllables are important linguistic units in reading. The response delay for syllables is smaller than the response delay to the initial phonemes of the syllable (Savin and Bever, 1970). Reaction times are fastest for the identification of two-syllable words, next fastest for initial syllables, and slowest for initial phonemes (Foss and Swinney, 1973). Response delay in same-different judgments increases with the number of syllables in the items being judged (Klapp, 1971). Also, accuracy of letter identification in two-syllable words is worse than for words of one syllable (Spoehr and Smith, 1973). Thus, syllabic units have properties that affect perceptual processing. A theoretical basis for, and some pilot attempts in teaching children beginning reading skills with the syllable as the basic unit, are discussed by Gleitman and Rozin (1973).

Morphemes. It has been argued that an important language access to reading is the word's structure units or morphemes--stem, prefix, and suffix, and that when these units are classified according to their final vowels and consonants, they can be arranged into six groups--an arrangement resulting in spelling and pronunciation principles with a negligible number of variations (Wolf, 1974). Wolf cites evidence that, in English, there are only 11 common suffixes, and that 14 prefixes account for 80 percent of the occurrences of prefixes in English usage. She estimates that highly educated English speakers use about 2100 morphemes, and that the average person uses about 1000. Evidence that morpheme units are attended to in beginning reading is provided by Söderbergh (1976, 1977).

Words. There can be little argument that written words are important language accesses to reading for mature and beginning readers. A study of kindergartners' attention and matching skills showed that the children's scores for visual matching tasks involving single letters were significantly greater than for letter clusters; however, the kindergartners' scores for single-letter tasks did not differ significantly from their scores for tasks involving the matching of whole words (Wanat, 1977). Thus, a word may be as easy to attend to and perceptually process as a letter, for children as well as adults, for it was long ago established that very quickly flashed words can be recognized as easily as a single letter (Cattell, 1886).

Grammatical category is a property that is attended to by the reader as he extracts meaning from written language, as shown by the tendency of adult readers to make substitutions that preserve the part of speech of words in text (Rumelhart, 1976). An analysis of oral reading errors of first graders concluded that "the frequency of errors on a given part of speech was proportional to its frequency in the text (Weber, 1970A)." However, re-examination of these data showed different error rates for different grammatical categories (Wanat, 1977). Wanat's re-examination shows that the error rate for verbs is approximately half the error rate for personal pronouns, common nouns, and function words. The verb error rate is somewhat smaller than the error rate for proper nouns. This re-examination of Weber's data suggests that, for beginning readers, the verb may be more resistant to change than other grammatical categories. With respect to mature readers, the verb was the grammatical category most resistant to having its part of speech changed by readers' substitution errors (Kolers, 1970, 1972).

The length of a word is another property that is attended to by the reader as he extracts meaning from written language (Hochberg, 1970B). Word length is a cue to the kind of information conveyed by a word (e.g., function words are short while content words are long). The length of a word is also a cue to the amount of information conveyed by a word (Goldman-Eisler, 1969). She found that informativeness was directly related to word length, and that cognitive (as opposed to grammatical) pauses in spontaneous speech were related to the unpredictability (informativeness) of the following word. Thus, Goldman-Eisler identified two pause systems operating in spontaneous speech--cognitively determined pauses and syntactically determined pauses. These same two pause systems have been identified in the visual pauses that the reader makes as he allocates his attention to text (Wanat, 1968, 1972, 1976A, 1976B).

Interword spaces are another property that is attended to by the reader as he extracts meaning from written language. When interword spaces are filled in, the loss of cues to word boundaries interferes with the reading fluency of older children, but does not have the same adverse effect on the reading of younger children (Hochberg, Levin, and Frail, 1966).

Phrases. The phrase is a linguistic structure that functions as a language access to reading for mature readers more so than for younger readers; the linguistic unit that mature readers "work on" in their short-term or working memory tends to be a phrase (Schlesinger, 1969). Evidence that phrases are treated as units in readers' allocation of attention to text comes from data showing that regressive eye movements tend to take place within, rather than across, phrase units (Kennedy, 1967), and from additional data showing that the reader's visual scanning of sentences is sensitive to their immediate constituent analysis (Mehler, Bever, and Carey, 1967; Wanat, 1968, 1972, 1976A, 1976B).

Clauses. It has been argued that the clause is the most significant language access to reading: "...meaning can be derived from written language only when underlying clauses and their interrelationships have been inferred. Thus, the most significant unit in reading is not the letter, word, or sentence, but the *clause*...(Goodman, 1972)." A study of the high speed extraction of semantic features explored the role of the clause in reading comprehension (Wanat, 1977).

This study showed that the ability of mature readers to correctly extract the semantic features of words from particular grammatical categories depended upon the type of clause in which that item appeared.

Sentences. Another linguistic unit whose properties affect the reader's allocation of visual attention is the sentence. Sentence types that are less structurally predictable require more visual attention on the part of mature readers (Wanat, 1968, 1972, 1976A, 1976B). Also, the ability to deal with the linguistic properties of sentence units differentiates between better and poorer young readers, for while both good and poor first grade readers show equal linguistic skill in substitution errors that are grammatically appropriate to the part of the sentence preceding their mistake, the good readers are far more likely to go back and correct a mistake that is grammatically inappropriate to the part of the sentence following their mistake (Weber, 1970A, 1970B). A study of the effects on a sentence meaning of oral reading errors made by second and third graders in a remedial reading program showed that the number of errors that rendered sentences ungrammatical was significantly greater than the number of errors that maintained sentence grammaticality while either retaining or changing sentence meaning; however, the occurrence of errors destroying sentence grammaticality was reduced 45 percent in the course of a supplementary instructional program, showing that young remedial readers can be taught to attend to the linguistic properties of sentence-level units (Wanat, 1977).

Text--beyond the sentence. The information in larger blocks of discourse is comprehended, stored, and retrieved by generating a "scenario" that holds the information together (Anderson, 1976). Study of the effects of inter-sentence constraints on the size of the linguistic unit that mature readers "work on" in short-term memory indicates that the connectedness between sentences characteristic of most texts increases unit size, and that this effect was significant at the 0.005 level; however, the magnitude of differences in processing unit resulting from manipulation of within-sentence linguistic constraints was two to five times as great as the magnitude of differences in size of processing unit resulting from manipulation of inter-sentence constraints (Wanat, 1977). Thus, while the inter-sentence connectedness of most texts does affect the size of the linguistic unit processed in the reader's short-term memory, differences in linguistic constraints operating within sentences have a far more potent effect on the size of the reader's linguistic processing unit. With respect to younger readers, the number of errors made on a text are, not surprisingly, related to the linguistic properties of that text (Wanat, 1977); however, whether those linguistic properties deal with inter-sentence relations (as was the case in the size-of-unit study above), or whether those properties deal solely with units no larger than the sentence, is not clear.

It can be argued that linguistic-cognitive operations such as "inferencing" can serve as important language accesses to reading. Whether or not one agrees with this, and whether or not one wishes to deal with linguistic units larger than--or even as large as--sentences as language accesses to reading, depends upon one's definition of reading, and one's beliefs about how higher levels of reading skill should be developed. As one moves away from consideration of such smaller-sized language accesses to reading as letters, grapheme-phoneme correspondences, and spelling patterns--units that would not exist without a written form of the language--and as one moves toward large-size linguistic units, it becomes less clear that one can refer to these larger units as language accesses to reading without adding the qualification that they are also accesses to comprehension of spoken language. In this view, operations such as inferencing would not be referred to as language accesses to reading, but as *language accesses to meaning*. Operations such as inferencing are broader linguistic-cognitive processes not limited to reading. Also, it can be argued that the comprehension of relations between and within sentences is not specific to reading. Given the evidence that when a new linguistic-cognitive competency is added through listen-

ing skills development, it automatically becomes accessible in the learner's reading activities (Sticht and James, 1977), it is reasonable to argue that the learner's oral language skills be used to develop as many language accesses to meaning as possible, and that the transfer of training principle be depended upon as the vehicle for making these linguistic skills accessible in the learner's reading. The transfer of training evidence, and the utility of this principle for reading development, underlines the need for coordinated inquiry into language and reading development, and it underlines the importance of inquiry into language as a means to analyzing reading comprehension. Following are brief notes on the contributions this collection makes to the analysis of reading comprehension.

The first two papers in this collection consider different approaches to the analysis of reading comprehension difficulties. Mackworth studied good and poor readers in grades two, four, and six, using a number of cognitive and behavioral measures to diagnose information processing breakdowns and delays. His analysis of these readers led him to ask: "Why do the poor readers have this great difficulty in predicting a missing word from the verbal context?" He found that, because of their difficulty in visually linking words, the worst readers had a very poor mental pattern of a sentence. However, the difficulties of the poor readers were not due to visual problems, for there was no real difference between the performance of good and poor readers on a non-verbal pictorial task. Mackworth concludes that the poor readers he studied are stimulus-bound word-callers, while the good readers are sensitive to verbal context and can predict what will come next. His study shows the kind of information that can be gained by studying reader's attentional processes, and it also shows the need to analyze individual differences in comprehension. Finally, Mackworth discusses the hypothesis that one cause of poor reading may be delayed development of the brain structures responsible for the production of purposive behavior, and for the creation of general intentions and plans.

The paper by Fisher and Smith outlines procedures for identifying the causes of an individual's reading comprehension difficulties. Their paper continues the discussion of attentional processes and individual difference as major issues for reading comprehension research by stressing the need for understanding how differences among individuals account for differences in comprehension performance with respect to a given text. Fisher and Smith discuss four influences on the reader's creation and development of relational structures to hold together--and make sense of--the text components he tries to comprehend. Next, the authors consider influences on word processing and the effects on comprehension of specific word-processing difficulties. Finally, they consider the effects of decoding speed on comprehension, pointing out that readers who have to allocate relatively more attention to decoding processes will be relatively less able to attend to and process higher levels of information necessary for accurate and efficient text comprehension.

The next two papers deal with commonalities and individual differences identified by research on language learning and some implications of that research for reading. In her paper, Menyuk points out that while the sequence in which particular linguistic structures are acquired is similar for children within a given linguistic community, there are important individual differences in the rates at which structures are acquired. Also, there may be important differences in the levels of analysis of sentence structure that different children are able to attain. These individual differences at the time of entering school may produce differences in the acquisition of reading. Menyuk's views about the possible affects of individual differences in oral language development on reading recall Mackworth's views about the possible affects of individual differences in the development of attentional processes on reading.

Following Menyuk, Wanat explores implications for reading of some research in developmental psycholinguistics. Specifically, he considers research strategies for studying commonalities and individual variations in the linguistic

units used by readers to comprehend print. First, he argues that research methodologies of developmental psycholinguists such as Brown and Söderbergh need to be used extensively by reading researchers and teachers to gain a better understanding of reading acquisition. Second, that the text-comprehension strategies of members of different language-background groups need to be studied to see if there are significant group and individual differences in the types of linguistic units attended to and comprehended. For this research, Wanat, like Mackworth, advocates use of line-of-sight measures--that is, qualitative and quantitative measures of the reader's allocation of attention to different kinds of linguistic units.

The next two papers explore cognitive style factors in communication and comprehension. Goldberg's paper deals with issues in the assessment of individual cognitive styles, and with problems of communication and meaning. Stauffer's paper emphasizes the nature and development of intention and curiosity as cognitive controls influencing both comprehension and thinking activities. Goldberg contrasts (a) the emphasis of much psycholinguistic research on individual commonalities as opposed to individual variations with (b) the emphasis of much psychological assessment on an individual's uniqueness with respect to cognitive or personality characteristics as opposed to commonalities across individuals. He discusses research on components of cognitive style such as selective attention, and research on relationships of these components to language behavior and to reading comprehension.

Stauffer notes that a basic element in strategies for learning is intention. His further comment that the purpose of the reader determines the nature and depth of his achievement, underlines the two themes in this collection of *what the reader attends to* and *individual differences* as major influences on reading comprehension. Stauffer's examination of the role of intention in reading, and of individual differences in the nature and development of intentions, recalls Mackworth's hypothesis that differences in reading may be caused by individual differences in the development of those brain structures responsible for the creation of general intentions and plans. He maintains that reading is a form of thinking, and that strategies of thinking must be learned, and therefore can be taught. His paper considers instructional implications flowing from these views.

Smith's paper discusses the types of linguistic units attended to in beginning reading. He comments on the limitations of look-say and phonic approaches, and notes that reading comprehension difficulties in the intermediate grades may result from excessive attention in the earlier grades by teachers and students to phonic principles as the strategy for decoding. He argues that linguistic context is an important source of information that should be attended to even in the early stages of reading. He suggests that children be trained in kindergarten and first grade in the use of context on an oral/aural plane, so they will feel comfortable with the use of linguistic context for decoding as soon as they begin learning to read. Smith discusses the types of information available in texts that decoding strategies can build upon, and he identifies the strategies that yield the greatest efficiency in decoding.

S.F.W.
April 1977

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The Line of Sight Approach

Norman H. Mackworth,
Stanford University

The line of sight camera can tell us just where a poor reader is having difficulty. The Reading Aloud Fixation Time (RAFT) score indicates how long, on the average, each look is at the reading material. The RAFT score permits an estimate of the number of words that the child can link together in his fast-fading visual image or iconic store. This initial image lasts for little more than a second, and during that brief period the words must be coded out into short-term memory.

Twenty-two children, aged 8 to 12 years, in Grades two, four, and six, were studied. Half of them were known to be poor readers. The RAFT scores for individual children were closely correlated with both their reading skills and with their ability to identify a word that was missing from a simple sentence. There was a correlation of +0.94 between the RAFT scores and the time taken to find the missing word among six alternative answers.

Why do the poor readers have this great difficulty in predicting a missing word from the verbal context? The RAFT scores for the best readers were just under 0.5 seconds, but the RAFT scores for the worst readers were twice as long. Thus the best readers might be called "two-worders," since they could easily hold two words together in the one-second iconic store, while the worst readers were "one-worders." These worst readers were unable to link two words together visually, since the first word would have faded from the iconic store before the second word could be added to it. (These estimates are based on the assumption, taken from the literature, that one visual fixation processes on the average no more than one word at the 10-to 12-year-old level.)

Because of this difficulty in visually linking words, the worst readers had a very poor mental pattern of a sentence. The one-worders took as long as 20 seconds to locate the correct word while the two-worders made about 40 percent errors on matching two words shown side-by-side and the best readers made only five percent errors. One-worders took three minutes to read a passage which the two-worders managed in half a minute. There was, however, no real difference between the two groups in their ability to do a nonverbal pictorial task. This suggested that the differences in the reading task performances were not due to motivational differences.

The one or two words held in the visual store are average estimates. It has been shown by earlier workers that the good readers' eyes led their voice by about two-and-one-half words on the average. At the beginning of the sentence the lead averaged three words, dropping later to two words. Poor readers, however, maintained a steady one-and-one-half word eye/voice span. (Adults show spans of three to five words.)

The one-worder is a stimulus-bound word-caller, but the two-worder is sensitive to verbal context and can predict what will come next. The ability to recall the sequence of words is known to be a function of the frontal lobes. Therefore, it seems likely that one of the causes of poor reading is the delayed development of the frontal lobes. This may be why some children are slow to become self-ruled readers, able to go beyond the information given.

HISTORICAL BACKGROUND

Nearly everyone knows that the eyes jump across the printed page by leaps and pauses. The history of this phenomenon has also progressed by leaps and

pauses. Indeed, across a century of research it is a story of interest which has waxed and waned. A feast of ideas has been followed by a famine. It is just 55 years since Buswell (1922) published his work on the relation between eye movement in reading and the intellectual processes of the reader. He showed that long fixations are symptoms of intellectual difficulty on the part of the reader. "The mental process of the reader is engaged in an effort to analyze the word, during which the eye increases the duration of its fixations in order to give time for the reader to arrive at a final solution of the difficulty (Buswell, 1922)." During the same year Judd and Buswell also reported that the requirement to paraphrase printed text greatly lengthened fixation durations as compared with the simple requirement to read the text. This additional cognitive requirement nearly doubled the length of the visual pauses. Dearborn (1906) had found earlier that pauses were longer on the first reading of a passage than on the second reading of that same passage (also see Huey, 1908).

The Pause Is Mightier than the Move

Carmichael (1957) summarized the theme of this chapter during his address to the 15th International Congress of Psychology at Brussels. "Eye movements can be useful in establishing the temporal limits for some of the higher brain functions that are basic to the intellectual act of the comprehension of meaning in reading." Ever since I heard this statement, I have wondered why even after 55 years, the idea has not been fully accepted.

The scientific world has long tended to neglect the pauses made by the eyes in favor of the eye movements. We therefore need to consider that it is almost 100 years since Javal (1878) described some of the earliest eye movement studies ever undertaken. He sat down and *watched* the eyes of children while they were reading. To assist him he used such specialized optical devices as a mirror and a magnifying glass. He discovered that the eyes did not sweep steadily over the page, but moved in jumps. (The fruitfulness of behavioral research is often inversely proportional to the complexity of the equipment.)

Although Javal discovered the pauses, it is something of a historical tragedy that Javal chose first of all to talk about the jumps: "Les mouvements saccades des yeux." By suggesting the motor movements were the more important aspect of visual behavior, this early work by Javal set the stage for others, despite the fact that Javal himself did later pioneering studies on the eye pauses in relation to reading. The dramatic rush of the eyes from *A* to *B* has an appropriately Parisian glamor and a flashing appeal. These attractions have too long obscured the fact that the eyes move in order to rest on a new object. We travel in order to arrive. The hours that we spend at home, at work, or sightseeing in a new city are the important ones, not the time spent in traveling. Similarly, the eye moves in order to arrive at a new place where it can gain information during its pause. We can therefore discover how the brain is directing the eyes by observing where and how long the eye pause rests on the outer world. The study of the placement of the eye pauses can tell us what we wish to know in cognitive research, especially in reading-related tasks. In particular, we can discover how words, phrases, or sentences interact with the reader's experience.

During the whole of the 20th century, data have been accumulating to support the idea mentioned by Huey (1908) that "most of the reading time is used in a fixed gaze on the page, but an inconsiderable portion of the time is used in the eye movements." Indeed, nearly all the reading time is spent with the gaze virtually at rest. This fact makes it all the more surprising that it is still necessary to enter a strong plea for the serious consideration of the visual pauses as a source of interesting data for cognitive research. The move exists only for the purpose of allowing the pause to occur in the correct place.

Line of Sight Research Is Different from Eye Movement Research

New terminology is needed to emphasize the distinction between eye pauses and eye movement studies. The simplest approach is to talk about *line of sight research* as distinct from *eye movement research.* Line of sight research deals with cognitive studies, while eye movement research deals with oculomotor control investigations. For instance, Mackworth and Bruner (1970) and Mackworth and Morandi (1967) describe research aimed at understanding how people think while they look at pictures. On the other hand, many investigations have greatly added to our understanding of the precision with which the eyes can follow moving targets (Stark, 1968). These are separate areas of investigation with distinctly different objectives.

Line of sight research methods can give us much information about the delays and the breakdown in information processing that are found in children with reading disorders. By watching where the reader fixes his gaze and how long he pauses on a particular word, we can study the interaction between the printed words and the stored reader's experience. In addition, much information can be obtained by special situations in which the reader is asked to solve some kind of problem. Such situations maximize the amount of relevant data that can be obtained in a brief recording time. For instance, Wanat (1968, 1972, 1976A, 1976B) has presented various kinds of linguistic grammatical patterns and has demonstrated by recording successive fixations the relative difficulties of these different arrangements of words. Nodine and Lang (1971) compared scanning strategies during paired word comparisons by kindergarten and third grade children. The two pseudowords in each pair differed only in the order of the two middle letters. The younger children were more likely to move their gaze to the unchanging outer letters than were the older children. The third graders quickly learned that only the middle letters were important in making the comparisons. Thus, a brief task could easily demonstrate growth in the ability to determine a rule.

Eye movement research, especially training of eye movements, has very little place in the study or teaching of reading. Goldberg and Schiffman (1972) have pointed out that "it is not the eyes that read but the brain." Dr. Goldberg is a professor of opthalmology, and at the end of the book the authors quote the official statement put out by the major American Societies of Pediatrics and of Opthalmology. In this joint organizational statement it is said: "There is no peripheral eye defect which produces dyslexia." The statement adds that "no known scientific evidence supports claims for improving the academic abilities... of dyslexic children with treatment based solely on visual training (muscle exercises, ocular pursuit, glasses [Goldberg and Schiffman, 1972])." Goldberg and Schiffman (1972) report an experiment which demonstrated that irregular eye movements of poor readers became normal when they had been taught the vocabulary of the piece which they were to read. The problem lay in comprehension, not in uncoordinated eye muscles. The brain delays the eyes until the text is understood.

Bond and Tinker (1967) were therefore completely correct when they pointed out that ineffective eye movements do not *cause* reading difficulties, but are the result of such difficulties. These authors also noted that "unfortunate emphasis on the mechanics of eye movements tended to direct attention to peripheral factors as determinants of reading performance rather than to the important central processes of perception and comprehension." However, Bond and Tinker went too far in the opposite direction when they denied that there was any point in studying eye movements of poor readers. On the contrary, *one or two minutes spent by the child in reading aloud as his eye fixations are recorded in an eye camera can give a more precise picture of the general verbal ability with print than any other method yet devised.* Line of sight studies have already proved to be important for diagnosis. Goldberg and Schiffman have already demonstrated the potential of this method for following even slight progress during

remedial reading. This use of the Eye Camera in helping the poor reader could be its most important function; it could help in both diagnosis and therapy.

Line of Sight Research Earns Its Place in the Reading Clinic

We cannot see what the brain is doing. We can only measure its action through measuring motor responses. We can only know what or how a child is reading by hearing what he says or watching where his eyes are pointing. If we take the point of view that eye movements are directed by the brain in order to select information from the outside world, then we can learn a great deal about this two-way flow of information by seeing what the eyes select. Moreover, by watching the eye pauses at the same time as the voice is recorded in reading aloud, the eye-voice span can be determined. This span is the number of words between the point fixated by the eye and the word being spoken. The span is longer in terms of words when the material is easier and when the reader is skilled, but the duration of this span remains fixed at about one second for skilled readers (Buswell, 1920; Geyer, 1968). Geyer showed that the eyes may regress or linger on a difficult word while the voice is steadily reading what has already been processed by the brain through the eyes. Geyer and Kolers (1974) state that "this remarkable independence of the visual system from those processes it subserves is possible only through the temporal buffering action of the Ready Store, a very brief visual store that lasts for a second or so after the eye has ceased to fall upon that image in the outer world." This iconic store (or Ready Store) was demonstrated by J. Mackworth (1963) as retaining the image for one second or so, during which time the subject could repeat digits from a tachistoscopic exposure, with an accuracy of 90 percent or better.

Prediction and Habituation

Skilled reading is characterized by effective prediction. People seldom look, without looking forward in time. They have decided where they will look next before they move their eyes, and they have also decided what they expect to find when they do make a visual leap onto the next important object or word. Mackworth, Grandstaff, and Pribram (1973) found that normal children soon turned their eyes away from a novel event; once they had decided that it was not going to change again, they looked away to see what else might be new. But children with speech disorders were either very slow to notice the new event, or else they locked onto it, and were unable to disengage. It appeared that these children with speech disorders were unable to form an internal model of a new event, which would free them from the need to keep on looking at it. Choice behavior that involves prediction needs to be studied in the reading clinic for both diagnostic and training purposes. The brain predicts what will come next in the stream of words, and then the eyes select the area that will confirm or deny the prediction. Thus visual choice, as demonstrated by line of sight, forms an important part of examining children with reading difficulties which include an inability to predict future words from what has already been read.

Studies of Line of Sight in Relation to Pictures

The cognitive action of the brain in directing the eye fixations was studied at Harvard in the early 1960s by Mackworth and Bruner (1970). Adults and first grade children were compared in the way in which they searched blurred and sharply focused pictures. Fixation times were considerably longer when comprehension was difficult than when the blurred picture had previously been seen in sharp focus. In the first case, the fixation times were about 400 milliseconds when the blurred pictures were seen first, and in the second case, the fixations lasted about 300 milliseconds when the nature of the picture was al-

ready known. The five millisecond difference between the mean fixation times for the adults and children was quite small, almost the same reading of about 330 milliseconds being obtained for each group, for the initial viewing of sharp pictures. This is in marked contrast with the considerable differences between the silent reading fixation times of beginning readers in first grade (550 milliseconds) and skilled adult readers (250 milliseconds).

Since the publication of the famous book *Eye Movements and Vision* by Yarbus (1967), there has been an increase in the use of pictorial situations to study cognitive processes by line of sight methods. For example, Vurpillot (1968) studied the growth of normal children's ability to plan their visual scanning to suit the situation's needs. Drake (1970) found the value of the line of sight approach in estimating the impulsivity of adults and children. Baker and Loeb (1973) examined the way in which unfamiliar geometric figures are scanned while Loftus (1972) discovered that representational pictures can be recognized in a further presentation after only three or four fixations initially. On the medical side, Tyler (1969) used line of sight methods to demonstrate that hypothesis formation about new pictorial situations is definitely impaired in people whose verbal mechanisms have been damaged by disease. Grandstaff, Mackworth, de la Pena, and Pribram (1974) found that speech-disordered children take twice as long as normals to report the presence of a matching shape after their eyes rested on the item for which they had been searching, even though the report was made by pointing.

It is surprising that recently the line of sight studies have been largely confined to pictures. It is necessary to redress the balance by giving equal time to the way in which the line of sight scans verbal material. The new direction has been indicated by such experiments as those of Wanat (1968, 1972, 1976A, 1976B) and Geyer (1966). Such verbal studies should prove most useful in studying the ways in which verbal processing is impaired.

USE OF LINE OF SIGHT STUDIES IN READING RESEARCH

The child who has difficulty in reading does not necessarily have speech difficulties, and in fact many of them are fluent speakers. Therefore line of sight studies need to be carried out during reading to discover where these children have difficulty. Much has already been done, from the early studies of such workers as Buswell (1922) to the major efforts of Tinker. More than a dozen of his articles are listed in the book by Bond and Tinker (1967). Imposing as it is, it would be a mistake to assume that we can now rely entirely on that body of evidence. Recent work using line of sight studies in cognitive psychology, psycholinguistics, and developmental psychology has shown how informative and versatile a tool this method can be.

However, there is a remarkable lack of investigation on comprehension of what is read. Even the available tests suffer from critical deficiencies, since the questions asked can often be answered by simple memory or paraphrase. Line of sight studies can reveal comprehension problems because where there is difficulty the eye will regress--pause for a prolonged period--or move haphazardly along the line. This lack of work on comprehension was disclosed during a recent major attempt to identify and synthesize the literature of research in reading with emphasis on models (Davis, 1971; Kling, 1971). Many of these key references contained new ideas that need to be introduced into reading studies. The ideas came not only from reading-related experiments, but also from investigations carried out by workers in cognitive psychology (Kling, 1971; J. Mackworth, 1972; N. Mackworth, 1972). Participation in this literature analysis prompted the following experiments on children aged eight to 12, who were known to be either good or poor readers.

Multiple Test Study of Young Readers

An intensive study of children from grades two, four, and six was carried out in a Palo Alto, California school. The aim was to discover the ways in which poor readers differed from good readers. A range of different tests was used in order to obtain individual profiles of achievement for each child. The tests were designed to investigate the different stages of the reading process: matching, coding, and comprehension (J. Mackworth, 1972). The teachers selected the children to be tested on the basis of their reading ability, with equal numbers of children judged as very good or very poor readers. Their general intelligence was rated as within the normal range, with a lower limit of approximately 100.

The material reported here concerns mainly the measure of comprehension and includes the use of line of sight measurements which are so informative in relation to comprehension. The parallel study of matching and coding has already been reported in detail in J. Mackworth and Mackworth, 1974.

Method

Reading Test. The child's reading ability was measured by the standard Gray Oral Reading Task (Form C). Each child was given the passage recommended for his grade level. The measure used was the total time taken to read the passage aloud. After a standard delay, prompting was given where necessary in the manner recommended.

Eye Camera Reading Study. Each child was tested in the simplified *Line of Sight Camera.* This equipment allows the child to rest his chin and his forehead against suitable rests. *No bite bar is needed.* The record includes the reflection of the material in the eye of the child. What he is looking at is seen in the center of his pupil. In the Reading Aloud Test he was asked to read the Gray Oral Reading Test (Form A), appropriate for his grade level. The scores used were the total time taken to read the piece aloud and the mean visual fixation time in seconds.

The same child was then given the Gray Oral Reading Test (Form B) and asked to read it to himself. Here the time was measured from the beginning of reading until he looked away from the material. This gave a measure of visual fixation times in silent reading. Finally, all the children silently read the *same* standard passage from the Iowa Tests of Basic Skills (Multi-Level Edition) for Grades Three to Nine (Form 4).

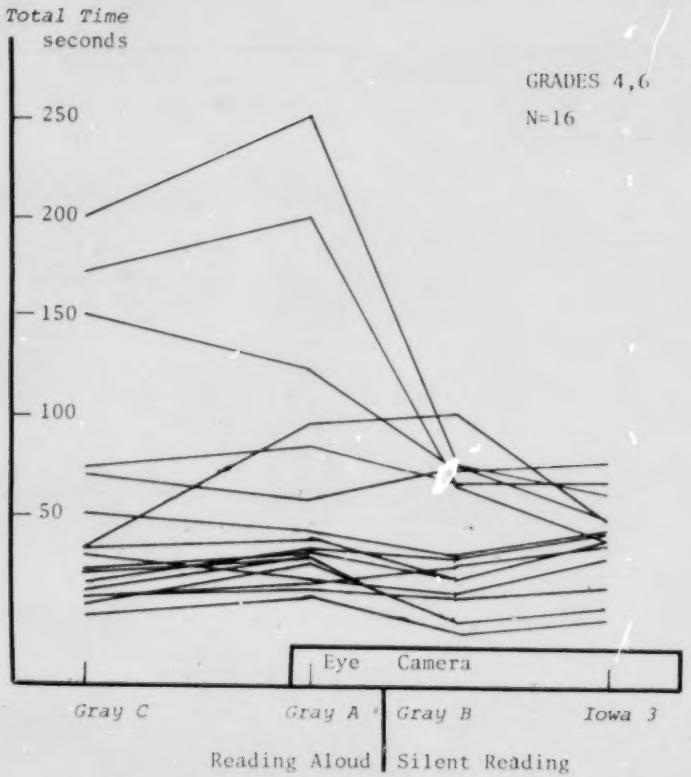
Subtests. The children were divided into six groups, two from each of the three grades: two, four, and six. In grade six there were five good and five poor readers; in grades two and four, there were three good and three poor readers per grade. The children included some drawn from minority populations.

Results

Reading Aloud Total Times. The total times in seconds for reading a passage aloud and for reading it silently are shown in Figure 1 on page 7. For individuals, the reading aloud total times were usually almost identical and in much the same rank order whether the test was made during free reading or by the Eye Camera. It is therefore clear that the use of the Eye Camera does not interfere with reading aloud. The standard method (of timing reading aloud) *is* an effective screening procedure, especially for picking out the worst readers, but this method does *not* enable the tester to rank these very poor readers taking more than 50 seconds since they are often quite unable to read the passage. Random vocabulary effects are responsible for making total time somewhat imprecise, and merely a good screening procedure.

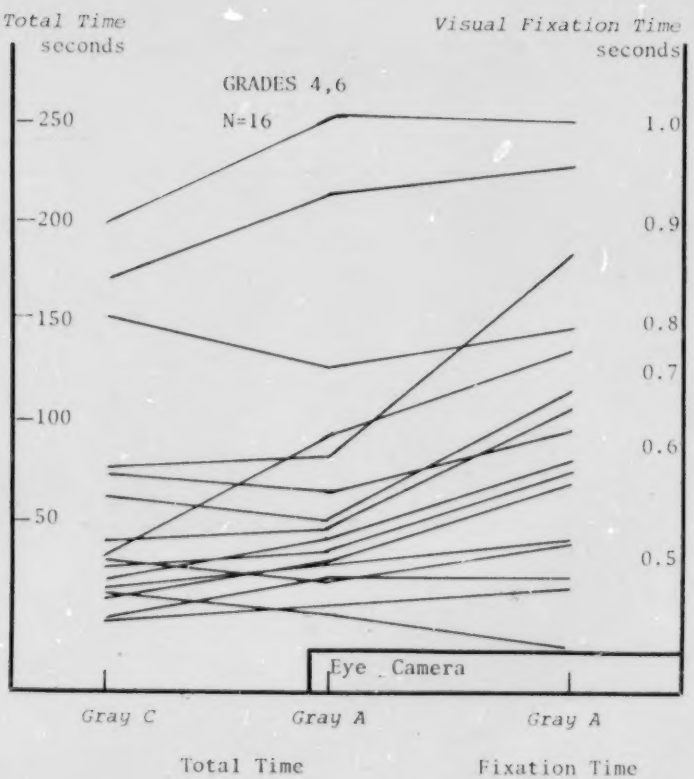
Silent Reading. Figure 1 suggests that the Silent Reading Total Time scores show dramatic reductions in the times taken by the three worst readers, as com-

Figure 1



Individual Times To Read Passage

Figure 2



Reading Aloud: Individual Data

pared with their times on reading aloud. Even when they are reading matched passages, they *appear* to be reading much faster than they read aloud. But this appearance is most deceiving. The Eye Camera records indicate that the poor readers often skipped the last line or so of the test. They even on occasion left out the bottom half of the passage, in a frantic effort to turn in an apparently reasonable score. The poorest readers are most likely to do this, since they cannot read the material adequately. They seldom took more than one to one-and-a-half minutes as compared with their times of two to four minutes for reading aloud (see Figure 1). Thus the time taken to read material *silently* is a very faulty measure of reading ability, and should never be used.

Reading Aloud Fixation Time (RAFT). RAFT is a much more important and accurate estimate of reading ability. For one thing, more measurements are obtainable in the same period of testing time. Moreover, those very children in whom we are most interested (poor readers) give us the most data. Poor readers make more pauses within a passage than do good readers; they also pause much longer on each fixation than do good readers. The good young reader provides about 50 visual fixations of about 0.5 seconds average duration, while the poor reader shows an average fixation time of 0.9 seconds, making about 200 fixations while he is reading the passage aloud (see Figure 2, page 7).

The RAFT score is less sensitive to undesirable random effects of vocabulary, because the occasional word that is unknown to the reader is averaged out among the 200 readings, most of which deal with familiar words. It is quite surprising to hear how even the simplest words are read slowly and with a total lack of appropriate emphasis by these poor readers. Clearly, they can have little sense of the meaning of the passage. In future work with this test, it would be important to mark the motion picture records while prompting is being given; then, the effect of the occasional unknown word can be excluded entirely--or studied separately if necessary. At present the effects of prompting are somewhat uncontrolled, especially if only total reading time is recorded.

The RAFT score spreads out the children more evenly along the scale than does the total reading time (see Figure 2). This is believed to occur because the total reading aloud time includes the long pauses with unknown words. The child eventually must be prompted, which inevitably introduces a variable related to the time that the experimenter allows to elapse before the child is prompted. Such prolonged pauses can be eliminated from the analysis of fixation pauses, leaving a more informative average fixation pause which represents the time taken to read a known word. The good reader reads with his eyes well ahead of his voice, so that he can punctuate and emphasize the material according to the meaning. The poor reader processes the material so slowly that he is looking at the word that he is saying. The good reader reads aloud at a speed that is considerably slower than his silent reading, while the poor reader does not, in fact, show much difference between the speeds of reading aloud and reading silently, when allowance has been made for the amount of material that he actually read, as described above.

The Reading Aloud Total Time is useful as a screening test to locate and diagnose poor readers. The measurement of eye fixations during reading (i.e. RAFT) gives much more information about what actually goes on during reading. Immediate prompting for unknown words would be useful during this test since it helps to maintain the morale of the child. There might be something to be said for the measurement of eye fixations during silent reading since there is less pressure on the child. The relation between the duration of visual fixation times during reading aloud and reading silently is shown in Table 1 on page 9. On the whole, the fixations are shorter during silent reading than reading aloud. Thirteen of the 16 comparisons show this change. Also there is a correlation of 0.71 between the rank orders of the two kinds of reading fixations--the RAFT and the silent reading visual fixation times. The RAFT scores are more reliable, because in silent reading the very poor readers may just pass their eyes along the print without any attempt to understand it. Another practical point in

favor of the RAFT score is that it can be obtained at the same time that the Reading Aloud Total Time is being measured.

TABLE 1

Child No.	*Fixation Times (seconds)* Reading Aloud Gray Form A	Silent Reading Gray Form B	Difference (A minus B)
1	0.43	0.35	+ 0.08
2	0.47	0.31	+ 0.16
3	0.48	0.36	+ 0.12
4	0.51	0.40	+ 0.11
5	0.52	0.34	+ 0.18
6	0.54	0.53	+ 0.01
7	0.58	0.48	+ 0.10
8	0.60	0.50	+ 0.10
9	0.67	0.60	+ 0.07
10	0.63	1.10	- 0.47
11	0.70	0.60	+ 0.10
12	0.71	0.73	- 0.02
13	0.79	0.59	+ 0.20
14	0.84	0.86	- 0.02
15	0.93	0.85	+ 0.08
16	1.02	0.92	+ 0.10

Correlation Coefficient r=0.71

Mean difference	
Good #1-#8	0.11 secs.
Poor #9-#14	0.01 secs.

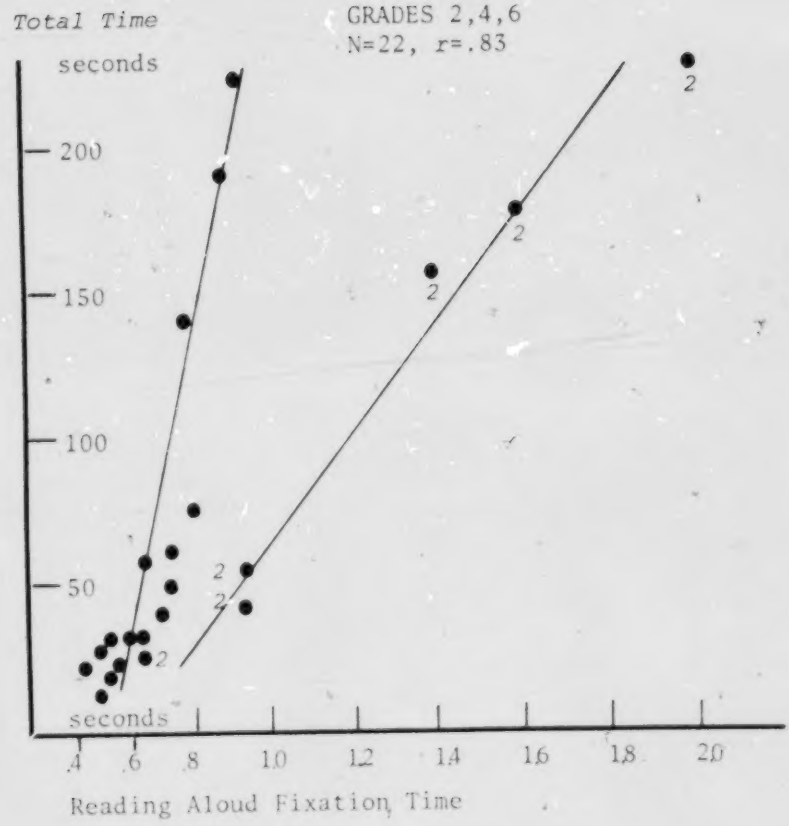
Relation between Reading Aloud and Silent Reading Fixation Times Grades 4 and 6, N =16

The RAFT score has a close relation to more traditional measures of reading ability, such as the total time taken to read a standard text aloud. This comparison has been made with all the 22 children tested; part of the value of the RAFT score is that it can be applied over a wide age range. The data in Figure 3 on page 10 show that the RAFT score is closely related to the total time taken to read the appropriate passage. A Pearson Product-moment correlation coefficient (r) of 0.83 is found between these two verbal ability measures of (a) RAFT and (b) total time to read, taken as a mean of the two different passages that were read aloud (Forms C and A). (If grade two is excluded, the correlation coefficient for the 16 children in grades four and six becomes 0.67.)

The RAFT scores can be used across a wide age range. Even though the children are given passages to read that are appropriate to their grade level, their eye pauses shorten in duration with increasing age. But within an age group, there is still a wide range in the duration of eye fixations, so that there is a considerable overlap between different age groups. Figure 3 shows the whole range of children from grades two to six, and it can be seen that the grade two children have relatively longer RAFT scores in relation to their total reading times than the older children.

The Ready Store sets limits to skill in reading aloud. Geyer and Kolers (1974) have discussed the way in which the visual image of words is preserved in a temporal buffer or Ready Store until they can be processed. But this Ready Store only lasts for about a second (J. Mackworth, 1963). Written words or letters will remain long enough for skilled readers to code three or four short words into sound. In reading, the Ready Store contains a constantly changing

Figure 3



Individual Times To Read Passage

set of words. The first word in the store fades away while the most recent word being looked at is put into place at the end of the sequence. Any reduction in the speed of the input or of coding will greatly reduce the ability to read the material as a connected and correctly segmented piece of prose.

The data shown in Figures 2 and 3 (see pps. 7 and 10) indicate that most of the *good readers in grades four and six had mean RAFT scores of less than 0.6 seconds. If the reader spends more than 0.6 seconds on each fixation, then his Ready Store can contain at most two words.* When his fixations lengthen to more than a second, there will be no extra words stored in his Ready Store. Thus, he is sounding out each word at the same time that he is reading it visually, and his input consists of a series of disconnected words. This can be clearly heard in the way in which he reads each word laboriously and with no normal speech rhythms. Since the longer fixations are associated with an increased number of fixations per passage, there is a logarithmic relation between RAFT scores and total times for reading the passage aloud.

The child who reads one word at a time is unable to make any predictions as to what will come next. His entire verbal brain is occupied with the one word. Therefore, his comprehension will be poor and there will be no activation of an internal model of a forthcoming word. Each word must be looked at while its stored model is located and used to code the word. All this seriously interferes with reading performance. He will never become a very efficient reader until he has learned to read at least three words per second, but since the difficulty arises within the brain, no improvement can be produced simply by teaching the child to move his eyes faster. The improvement can only come from an improvement in the ability to recognize, code, and comprehend the material.

THE MISSING WORD TASK

Since we only used the Gray Oral Reading Tests for discovering how fast a child can read, it is necessary to present evidence that there was a direct relationship between the speed of reading and the ability to comprehend what was read. The Eye Camera method can be used to indicate failures in information handling. By its use we can discover not only how slow the child is in reading, but what kinds of difficulty he demonstrates when asked to solve a simple verbal problem. The Cloze test has been used for some years to examine a child's cognitive abilities. In this Cloze test the child is asked to produce from his memory a word that is missing from a sentence. Weaver (1965) has made the point that the Cloze procedure indicates the semantic and syntactic effects of context on language skills. Goodman (1965) reported that many children in first grade can read words in context that they cannot read in isolation. Treisman (1965) has suggested that data on latencies indicate that there is a two-stage search for a missing word. Oldfield (1966) reported that retrieval of a word or name depends on the familiarity or frequency with which the word is used. Miller (1971) indicated that sentence context is important to study when workers are investigating the subjective lexicon stored within the brain.

The successful search for a missing word mostly depends on recognizing which part of speech is required. The present Missing Word Task requires the child to select the missing word from one of two categories of words, such as nouns and verbs. When he is asked to do this we can record where he looks. If he spends an abnormally long period of time looking at the area of the page containing the wrong kinds of words, it is clear that he has difficulty in recognizing parts of speech. Briefly, when the line of sight rests too long in the "ungrammatical corner" of the given verbal problem, then it can be assumed that the child is not making use of the syntactical information available to him.

Method for the Missing Word Test

The child is seated in front of the Eye Camera. He is shown a projection

slide which has a sentence at the bottom, and two columns of three words each in the upper left and right hand corners. The left-hand column shows three nouns and the right-hand column shows three verbs. The child was told that the left-hand column would show names of things and objects, and the right-hand column would show action words. The child was given one practice problem, with full explanation. He was asked to press a button when he had solved the problem. This button automatically removed the slide, and the total exposure time was recorded. The sentences used were very simple. One was: "He could not carry the _____." With this the noun column showed books/year/sky and the verb column showed ran/threw/makes. There were six test slides, three with missing nouns and three with missing verbs, presented in random order.

Scores Used in the Missing Word Test

Three different measures were used for each child. The *Total Time To Find* was the total time taken by the child to arrive at an answer, whether right or wrong. The *Wrong Category Time* was the mean time spent in looking at the wrong category or column of words. This score was averaged separately for the nouns and for the verbs. The *Sentence Reading Frequency* was the number of times that the child scanned the sentence or returned to it for a new look. This measure also was averaged separately for nouns and for verbs.

All 22 children who had already been tested with the reading passages were used in the Missing Word Test. There were 10 children in grade six and six each in grades four and two.

Results of the Missing Word Test

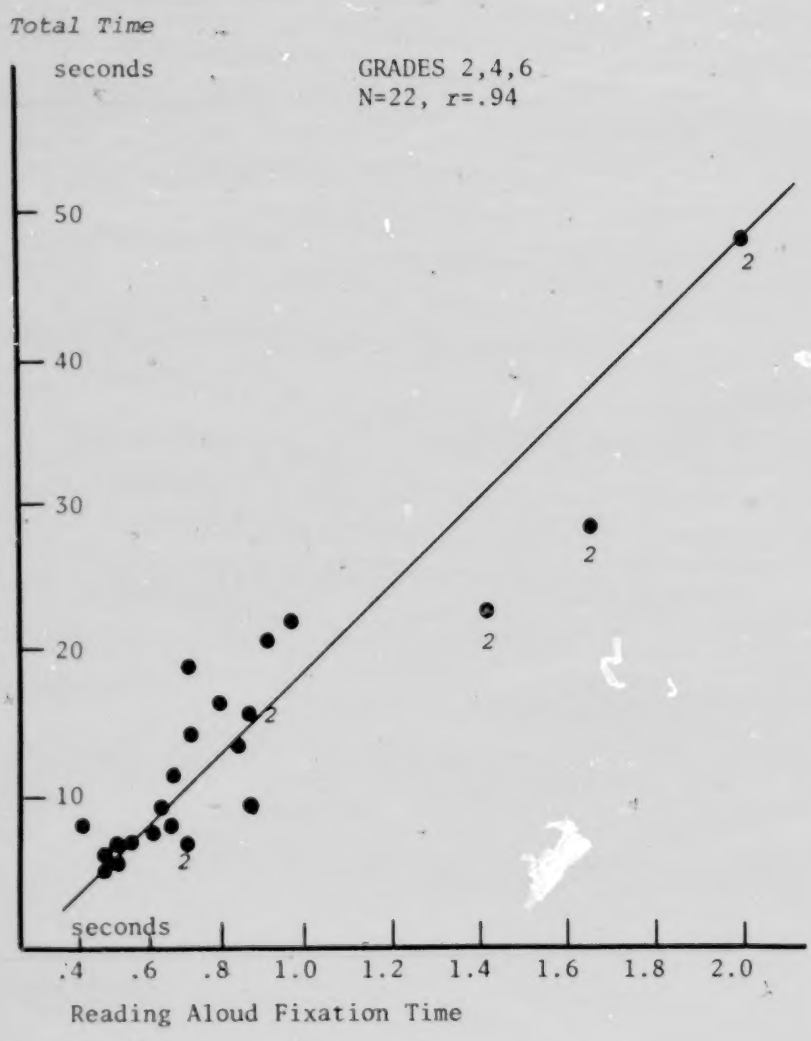
Visual Fixation Times Predict General Verbal Ability. There was a strong relationship between the RAFT scores (fixation times) and the score on the Missing Word Test. There was a Pearson correlation coefficient (r) of 0.94 between the RAFT scores and the total time to find the missing word, when all 22 children were considered together. The correlation between the RAFT scores and the time spent looking at the wrong category (averaged over nouns and verbs together) was 0.87. These two high correlation coefficients prove that the Reading Aloud Fixation Times were indeed able to predict the ability of children to think out the answers to problems involving the use of verbal context (see Figure 4, p. 13).

Grade Two Children Differed Greatly among Themselves. Figure 4 on page 13 suggests that some of the grade two children can undertake the Missing Word Test with reasonable success. It has long been known that children can use semantic and grammatical contexts years before they can formulate the rules or principles on which they are acting. Anglin (1970) pointed out that, "employing principles, and being cognizant of them, may reflect very different cognitive capacities." The natural use of the syntactical context involves the recognition that members of the same grammatical class can be grouped together. While our second grade children (aged about seven years) were able to choose the correct category in which to find the missing word, Anglin has shown that it takes at least five more years before the child can correctly sort single words into separate parts of speech, as in the task given by Miller (1971). The presence of the context is an essential element in the early recognition of the category of a word.

In the Missing Word Test, the best Total Time To Find was 4.4 seconds, a speed achieved by a child in grade six. The best Total Time To Find score in grade two was 7.4 seconds (see Figure 4). This was well within the range of scores achieved by the older children. But those children in grade two who could hardly read at all gave times as long as 47.1 seconds. This was more than twice as long as the times given by the worst readers in the two higher grades. It was therefore decided to analyze the two higher grades together, and treat the grade two children separately.

Further Evidence that RAFT Scores Predict General Verbal Ability. Figures

Figure 4



Time to Find Missing Word and Reading Aloud Fixation Time

5 and 6 on page 15 give evidence that the visual fixation times measured while the children were reading a passage aloud (RAFT score) give a reliable measure of the general verbal ability of the children.

Figure 5 shows the *Total Time To Find* scores for nouns or verbs in relation to the RAFT scores of the children. The children were grouped according to their RAFT scores, with three or four children in each group. (The three RAFT scores of 0.8, 0.9, and 1.0 seconds were joined into one group.) The time to find a noun or a verb was averaged across the children with a RAFT group. The results show that children with prolonged RAFT scores averaged between three and four times as long to find the missing nouns or verbs, respectively, as compared with the children with the lowest RAFT score.

The prolonged time to find the correct word shown by the poor readers was partly due to the fact that they spent much time *searching in the wrong category*. Figure 6 (p. 15) shows that the poor readers spent seven times as long as the good readers in looking at the noun category when they should have been looking at the verbs. This predilection for nouns reduced the time spent in looking at the verbs, but even when the missing word was a noun, the poor readers spent three times as long as the good readers searching the verb category.

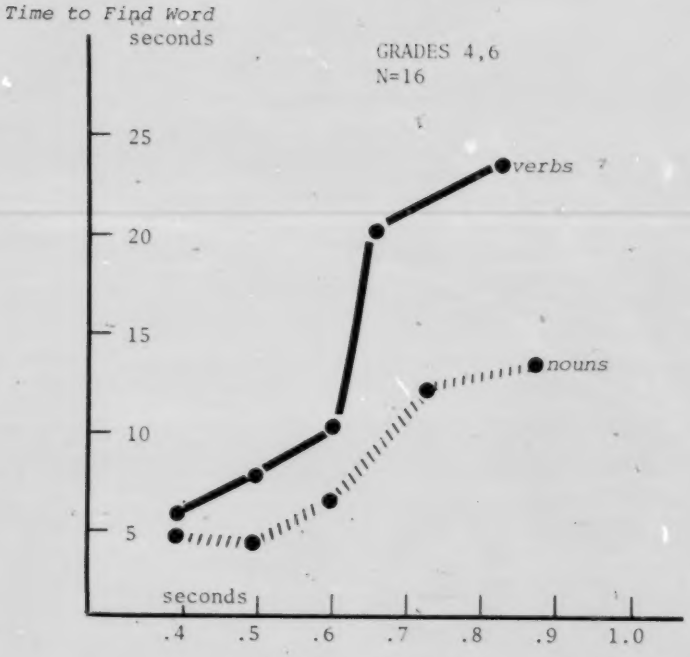
Ready Store Limitation by Longer RAFT Scores. We have discussed the idea that when the fixations are longer than 0.6 seconds there is a serious reduction in the number of words available in the Ready Store, which lasts for about a second. Figure 6 shows a dramatic upswing in the failure to search for a noun in the noun category. This upswing occurs between the groups with RAFT scores of 0.6 and 0.7 seconds. Figure 7 (see p. 16) shows the frequency with which the RAFT groups read the sentence, and here we see an upswing in sentence reading with a missing verb between 0.6 and 0.7 seconds with RAFT groups. This indicates that the memory of the sentence was particularly impaired when a verb was required. When the iconic store is cut down to about two words, less use can be made of the verbal context. Verbal prediction becomes more difficult for both syntax and meaning. Visual choice from the printed display becomes less purposive, and the tendency to search the noun column rather than the verb column overrides any real understanding of what grammatical category is required.

Frequency of Sentence Reading. The correlation between the *frequency of sentence reading* and the RAFT scores was somewhat lower (0.70) than the correlations between RAFT and times recorded in the Missing Word Test. Figure 7 demonstrates that the trends are less dramatic. For instance, the children with the longest RAFT scores in grades four and six read the sentence only about twice as often as the children with short RAFT scores.

The child with moderately poor comprehension is more likely to read more slowly than he is to re-read the sentence several times. The total time spent on reading the sentence was a composite of the time taken to read it each time and the number of times that it was read. The time taken to read the sentence is itself a composite of the duration of each fixation and the number of fixations. Both these measures increase as reading difficulty increases. Therefore measures of total time increase very much faster than the measure of frequency of reading. If each of these three measures were doubled between good and poor readers, the final result would show the poor readers taking eight times as long as the good readers.

Why Were the Verbs So Much More Troublesome for the Poor Readers? The facts are clear, but the interpretation of the facts is not. Figures 5, 5, and 7 (see pps. 15 and 16) all show that the missing verbs were more difficult than nouns for the poor readers. Nouns occurred at least twice as often as verbs in speech and writing, and are learned earlier in life than verbs. Brown (1957) noted that three to five-year-old children use more nouns than verbs, and Halpern (1965) reported that brain-damaged asphasic adults have more trouble in calling out verbs than nouns. This finding may be related to the fact that verbs are more abstract than nouns; Marshall, Newcombe, and Marshall (1970) found that abstract nouns are just as difficult as verbs for such patients.

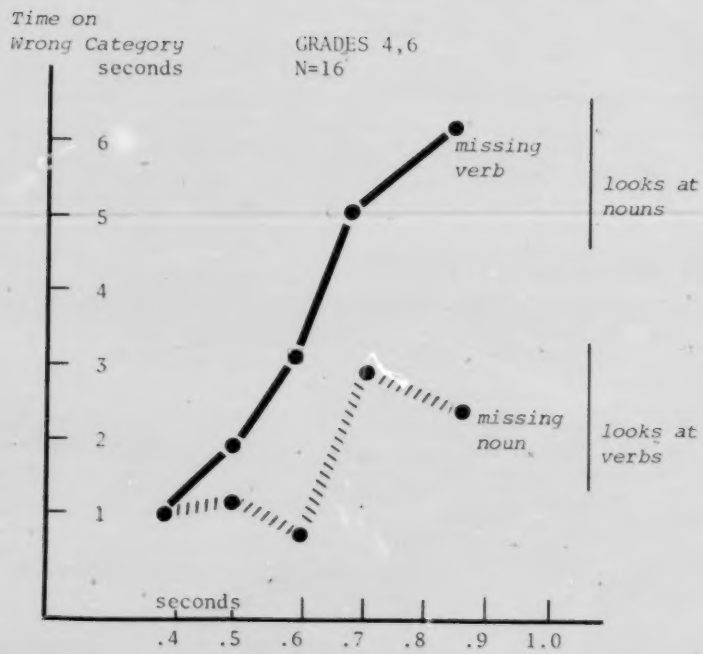
Figure 5



Mean Reading Aloud Visual Fixation Time

Reading Ability and Missing Word Latency

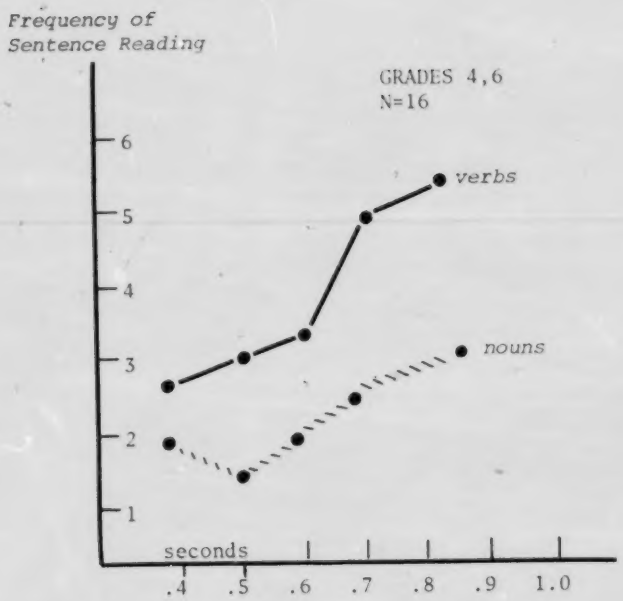
Figure 6



Mean Reading Aloud Visual Fixation Time

Visual Choice of Wrong Category

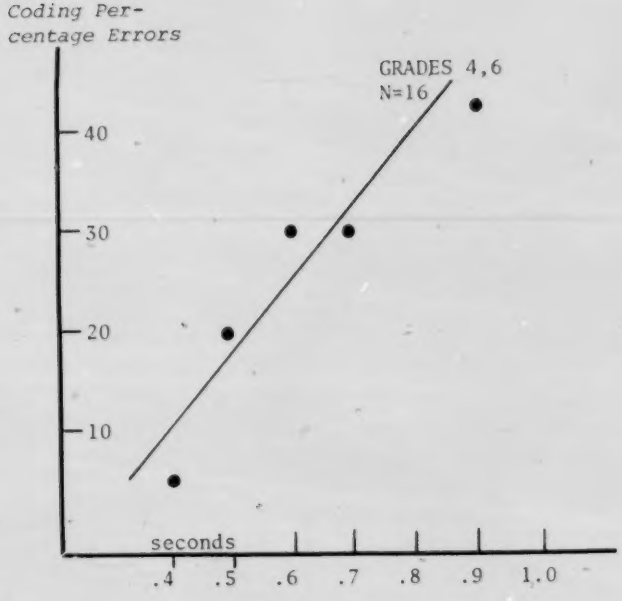
Figure 7



Mean Reading Aloud Fixation Time

Reading Ability and Sentence Reading

Figure 8



Mean Reading Aloud Fixation Time

Coding and RAFT Scores

Three possible explanations of the advantage of nouns over verbs may be entertained with regard to the Missing Word Test. We do not believe that they are in fact *the* explanation, but it will be necessary to design further experiments to refute or confirm these hypotheses. They are:

The particular verbs used, or their framing sentences, were more difficult than the nouns or the missing-noun sentences. Since some care was taken to confine the study to the most familiar and the simplest possible words, it is doubtful whether this explanation is viable.

The nouns were always in the left-hand column. The eyes may have turned to the left first because this is the natural place to begin reading. Since they were told which column was which in the practice test and again told that these categories would remain in the same place, this again seems an unlikely explanation of the great differences found between good and poor readers with the two categories. Also, we found that in a later test with prepositions and adjectives, the prepositions were easier, although they were always on the right-hand side of the display.

The poor readers may have been more likely to draw the wrong conclusion that because the practice test had a missing noun, the correct answer, therefore, was more likely to be found in the left-hand column.

An Account of the Troubles of One Confused Reader. Since our whole program of testing was aimed at an analysis of individual difficulties, it is appropriate to end the Missing Word Test with the brief profile of the worst reader in grade six. This 12-year-old girl took 202 to 250 seconds to read the two Gray Oral Reading passages aloud. This represented about five seconds per word. Her RAFT score of visual fixation was 1.02 seconds. (Her data can be seen at the top of Figures 1 and 2.) This meant that her *one-second iconic store could hold only one word at a time.* On the Missing Word Test she averaged 26 seconds for the missing verbs. During this search for the missing verb, she divided her time almost equally between the three available areas of print. Apparently making a random search, she spent 10 seconds on the wrong category of nouns, nine seconds on the problem sentence, and the remainder of seven seconds on the correct category of verbs. As a reader she certainly had problems, but she gained our respect as a very real trier. She studied the sentence on an average of six to seven times, while trying to make up her mind. What went on in that mind, while she looked at this very simple sentence, we shall never know. But we do know she was making no use of the verbal context, and had but one word in her iconic store. The teacher's report said that she was reading at the third or fourth grade level. She was said to read very slowly, and to substitute words for those she did not know. Sometimes she invented words such as *tooken* or *borned.* This attempt to apply inappropriate rules to words is reminiscent of the way in which children who are just learning to speak will produce words that they have formed by using an inappropriate rule. She was also described as being confused by some verb forms. Yet her verbal WISC score was 97, just about average. Her WISC performance score was 107, the full WISC being 102.

THE CODING TEST

Another test which was given to these children in the elementary school was the Coding Test (J. Mackworth and Mackworth, 1974). This test required the child to decide whether two words shown side-by-side sound the same or not. Figure 8 (p. 16) shows the percentage of errors that were made on this coding test, in relation to the RAFT groups that have already been discussed. It can be seen that there is a close relation between these two scores. The ability of the child to sound out a word is an essential part of normal reading, and these data clearly show that all stages of the reading process are impaired in poor readers. Matching, coding, and comprehension are all connected, and the eye fixations demonstrate the internal difficulties that are going on in these three stages.

THE PATCH TEST

Non-verbal Pictorial Processing Is not Related to Reading Ability

Many authors claim that the ability to process pictures is related to the ability to read print. To test this theory, the children were given a pictorial task which could be carried out without verbal activity (J. Mackworth and Mackworth, 1974). The task consisted of a series of pictures, each of which was shown twice. These pictures provided simple, but interesting scenes such as a dinner table photographed in color, showing a children's party table spread with delectable food and cakes. Other scenes ranged from very simple pictures of a mother and child to complex, almost abstract pictures of flowers and scenery. Each picture was partially obscured by a number of black squares arranged randomly. After the picture was shown once for five seconds, it was shown again, with an extra piece of the picture now visible, because one of the black squares had been removed. The child was asked to place his finger on the piece of the picture that was new. This was demonstrated with the first very simple picture.

This task involved the minimum of verbal processing. The child formed a visual or iconic template of the picture and then mentally fitted this over the same picture when it was shown for the second time. He was then able to notice the difference between the two presentations. The data showed that there were no significant differences between the good and poor readers on this task; the percentage of errors was totally unrelated to the RAFT score. For example, the groups of fourth and sixth grade children who fell into the .4, .5, .6, .7, .8, and 1.0 seconds gave percentage errors on the Patch Test of 31, 31, 28, 28, and 27. The best Patch Test score of 20 percent errors was given by the worst sixth grade reader, whose RAFT score was 1.02 seconds. The Patch Test was given to 60 children in all, and it was found that there was some improvement with age, with a mean percentage error score of 37 percent in grade one and 25 percent in grade six.

DISCUSSION

Six main facts have been established in this paper. *The individual RAFT score is the average visual fixation time obtained during reading aloud a standard printed text suitable to the grade level of the child.* The RAFT score can predict the average rate of reading aloud for that child (Figures 2 and 3).

Far more interesting is *the finding that this RAFT measure provides a reliable indication of general reading ability.* The length of the visual pause under standard conditions is closely related to several different cognitive skills associated with reading comprehension and the use of verbal context, both semantic and grammatical. The RAFT score correlated 0.94 with the total time to find a word missing from a simple sentence, and 0.87 with the time spent looking in the wrong category of words (Figures 4, 5, and 6).

The children with the longer RAFT scores were real triers. They read the Missing Word sentence at least twice as often as the good readers.

The RAFT scores are closely related to coding skills. For example, the three children in grades four and six with the longest RAFT scores were so bad at sounding out words that they made more than six times as many errors in coding as did the three children with the briefest visual pauses (44 percent as opposed to 7 percent).

If time does not permit the use of the RAFT score, then a *useful, practical screening test is the Gray Oral Reading Test,* appropriate for the grade level of the child. However, an important proviso is that it is essential to have the child reading aloud rather than silently to prevent cheating.

The RAFT score does not predict performance on a purely visual pictorial task, except insofar as both show some improvement with age. Reading and pictorial processing are two quite different abilities.

ALRIGHT, WHY CAN'T JOHNNY READ?

Several reading practitioners have mentioned to me that it is not unusual for a poor reader to help another by the buddy system, working in pairs. Sometimes a well known but puzzling feature of this situation occurs: Johnny may be monitoring the reading aloud of his buddy, Mike. When Mike makes a mistake in his reading, Johnny will catch it and correct the mistake. Immediately afterwards, Johnny reads the passage himself, and may make the very same mistake that he had already corrected in his buddy's reading. This may simply be due to recognition that the word did not sound right in the spoken sentence that was read to Johnny. Listening to speech is directly related to the all-important speech motor programs. But there is another possible explanation.

The Stimulus-Bound and the Self-Ruled Task

The monitoring of another's reading is a good example of a stimulus-bound task. But reading aloud is quite a different matter; this could be termed a self-ruled task.

The monitoring task involves the simple matching of spoken and printed patterns. This can be regarded as a *stimulus-bound task* because it makes no great demands on the ability to use self-instructions to do the work. This routine matching can be done (and is done) word-by-word; there is therefore no need to use the verbal context to guess what is coming next. Even the rate of work is predetermined by outside environmental circumstances. This pattern-matching is information processing with minimal opportunities to work with the stimulus input in anything but a standardized manner. The stimulus-bound listening is a more passive activity than the actual reading aloud. Little is required in the way of prediction. The rules are there and are already laid down. Johnny finds this an easier task than the actual reading aloud, just as he can process the stimulus-bound visual pattern of the Patch Test.

In contrast, the reading situation itself is much more open-ended, if it is to be more than word calling at one word per second. Reading is a *self-ruled situation*. No longer is this a matter of following along a given path with no chance to change the rules of the game. The reader must be forward looking if his experience is to be ready and waiting when his eyes light on the predicted word patterns. The reader who manages two words per second is like our best second and sixth grade readers. They can clearly phrase their utterances. To do this, the 120 wpm reader is well on the way to skilled performance, which requires the interpretation of the context. Self-ruled tasks are a totally different kind of situation. They are likely to tap the main defects in the processing abilities of the individual with reading difficulties.

The *self-ruled situation* is too important to be left to the stimuli. The good reader interacts more actively with the stimuli. This skilled performer is relying on the context to let him predict the upcoming meaning and grammatical constructions that will shortly be fixated directly. The essence of the game is to create a temporary stabilization of the fast-changing verbal situation. The short-term memory can establish this baseline for prediction only if it gives a temporary buffer store which lines up at least a short series of three events.

This directionality is what is lacking in the word caller reading aloud at one-to-five seconds per word. He cannot transform the situation and therefore allow his inner models to be activated before he comes to the next printed words. He is stimulus-bound. The word callers haltingly plod along the simple printed path with but little in the way of changes in plan. It seems that poor readers can process information, given the correct instructions, but they are lacking in the ability to *plan* the processing of information by picking the most appropriate subroutines to deal with fast changing requirements.

The Key Role of the Frontal Lobes

The reading task is therefore a more difficult task than the monitoring task, since the range of choice is wider. Reading is concerned with the self-supervision of the possible ways to process rather than merely the processing itself. It has long been known from the work of Luria (1966) and Milner (1964) that the discovery of the rules and self-critical activities are the role of the frontal lobes. Especially valuable is the neuropsychological distinction Milner (1971) has recently drawn between the role of the frontal lobes and the temporal lobes in adults. The *recognition* of single words is a function of the temporal lobe not affected by frontal lobe damage. But the perception of the *sequencing* of a series of words is largely a matter of frontal lobe function not affected by temporal lobe damage.

Pribram 1971, 1973) has established that the segmenting of a series of events is a frontal lobe function. He has also noted the key role of the fronto-limbic system in registering a series of novel events. An external trend in the environment must at least temporarily be stored in the brain as a neurological context against which further stimuli can be compared. External environmental context becomes an internal neurological context or the organism is stimulus-bound. He orients to everything and cannot find the essential changes. *Prediction from experience cannot come through a narrowed short-term memory window.*

Clark (1969) made the point that reading and writing are the hallmarks of civilization. He remarked that civilized man must feel that he belongs somewhere in space and time. To do so, he must consciously look forward and look back. Even during the reading process itself the reader must look back in order to look forward. But his "catch-22" is that he has to work at high speed through his short-term memory accessible via only a narrow time slot. Poulton (1962) demonstrated that physically narrowing the moving slot through which men are reading aloud to six degrees (or about five printed words) begins to lead to mistakes, when the spoken rate was at least 300 wpm, but the short-term mrmory can place mental limits that are even more disastrous. In children, it is as if long-term memory stores are not searchable when the context does not provide a directionality based on about three words in a row. Baker (1972), Bryden (1972), Blank, Weider, and Bridger (1968) as well as Goodnow (1971) have all noted that poor readers have difficulties in short-term memory, especially when the material cannot easily be verbally rehearsed. The present author believes that this is because in poor readers the short-term memory cannot provide the proper context or subroutines to use in the searching of long-term memory. Other work makes it clear that long-term memory search time is at least doubled in some poor readers (N. Mackworth, 1974).

The Frontal Lobes in Reading

The role of the frontal lobes in reading is normally thought of in terms of the general production of purposive behavior. They create general intentions and plans to regulate and control subsequent actions by self-criticism and evaluation. But Luria (1966) and Pribram (1971) stress that the frontal lobes organize behavior in an even more direct manner during serial tasks. They have ongoing supervisory or executive functions which maintain a running analysis of actions and thoughts to keep the main intention uppermost. Seemingly then, this frontally controlled self-regulatory behavior is highly dependent on the short-term memory during reading.

Constant checking of the work strings would seem to involve at least five processes. These are the foundations of the advance early warning of needs (the cognitive search guidance of Hockberg, 1970A) which brings the most urgently needed subroutines to work within the short-term memory as needed. The five stages are: (a) external visual scanning using hypotheses to establish external

context--a grouping of elements; (b) transforming this external context into an internal context, which Pribram describes as a temporary neurological organization of brain events--this occurs in the short-term memory; (c) requests from short-term memory to long-term memory for subroutines; (d) further comparisons between internal short-term memory context and growing external semantic and syntactic trends; and (e) decidions to change or keep current subroutines if expected and actual events are diverging or converging.

In brief, the limited short-term memory of young children aged three to four years allows them but a piecemeal approach to organizational tasks. Inheider and Piaget (1964) note how normal children have to be seven-to-eight-years old before they can start with a plan in the organizing of colored counters of various shapes. At five- to six-years old they are still muddling through from empirical groupings to a plan. Brown (1973) has evidence that the ability to recognize and convert spoken word order is one of the last verbal skills to develop; it is related to other established measures of verbal ability.

Late Development of Frontal Lobes

When normal children are just barely able to plan in serial tasks at grade one level, is it surprising if some children have difficulty in reading? It seems most likely that some prolongation of the normal late development of the frontal lobes is responsible for at least some reading difficulties. Slight delays of a year or two could make it hard for the child to undertake the segmental processing involved in reading. The conclusions here are that it is likely that delayed development of frontal lobes is responsible for at least some poor reading achievement. Secondly, we need more direct comparisons between the word callers in sixtn grade and the word callers in the second and fourth grades. Are there any detectable qualitative differences in their performance? Thirdly, these poor readers in grade six should be classed as late developers until or unless they are proved otherwise. The fact that they lack frontal lobe abilities does not, of course, mean in any way that they are brain damaged. Fourthly, the special experience that can help frontally damaged adults to link their thoughts and keep to the main theme may well give research ideas for better training methods. Fifthly, one approach here is to try to link together separate elements in the environmental context so that the poor readers can make more active use of meaning and grammatical hints to think in a more directional manner. No longer would the printed stimuli bind them and steal their time.

CONCLUSIONS

The recording of line of sight fixations is a very useful tool in the study of reading. The child who has difficulty in processing the printed word shows prolonged eye fixations. These long visual pauses indicate his inner cognitive struggles with the material. His problems begin with the difficulty in activating the visual record of the word, continue with an impaired ability to sound out what he sees, and become most oppressive with his inability to understand what he reads. This failure of comprehension stems partly from the fact that his visual and short-term memory are unable to retain enough of the material for him to achieve a reasonable synthesis of what he is trying to read. The prolonged visual pauses ensure that the words so painfully processed fade away before they can be linked together. This piecemeal acquisition of words can be clearly heard in the monotonous slow expression of one word at a time. Anyone who has listened to a very slow talker will recognize the frustration and impossibility of following the sense of what is being said. However, the fact must be clearly recognized that the child will not be cured by teaching him to move his eyes faster. The teaching must begin at the other end of the cognitive chain, and try to ensure that the child has both the coding skills and the vocabulary he needs.

The poor reader aged 10 to 12 is not necessarily brain-damaged, but he may be a slow developer, especially with regard to the crucial frontal lobes that allow him to look ahead. His thinking is held closer to the present moment than it should be. He cannot link together successive stimuli into a trend. Lacking adequate external and internal contexts against which he might place the fast-changing stimuli, he cannot reach his stored experience. The normal rate of cognitive development is so fast that large effects are produced by one-to-two years lag in the development of the frontal lobes.

Acknowledgements

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An Information Processing Approach

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This paper suggests several procedures relevant to the diagnosis of reading comprehension problems. Three general beliefs have guided the development of these procedures: (a) Existing diagnostic procedures often mislabel or misclassify certain responses of the reader. (b) Diagnostic procedures could attend more closely to the effect a given reading problem has on comprehension. (c) Some of the knowledge gained from research in linguistics, education, and psychology can be usefully turned into diagnostic tools.

The first belief is based upon research in psycholinguistics (see Fodor, Bever, and Garrett, 1974). This research suggests that most word processing is active--the reader identifies words on the basis of existing syntactic and semantic information, and on information from the visual display. Since there are many competing determinants of the success or failure of any given attempt to identify a word, diagnostic instruments often fail to identify the different causes of word processing errors.

The second belief is the result of our examination of existing diagnostic instruments (e.g., Gray Oral Reading Test, Durrell Analysis of Reading Difficulty).

Finally, an examination of the literature in linguistics and artificial intelligence suggests that certain results of this research could be applied to problems which are presently very hard to pinpoint. Most of the work is broadly applicable to what might be called the understanding of connected discourse or, text.

TEXT PROCESSING

Text processing and text description are one focus of current research and theorizing in linguistics (see Crothers, 1975), psychology (see Freedle and Carroll, 1973), and artificial intelligence (see Schank and Colby, 1973). Unfortunately, little attention has been paid to individual differences that account for performance differences with respect to a given text. We know something of why one form of a passage is more easily learned than another (Brent, 1969; Lesgold, 1972; Paivio, 1971; Pompi and Lachman, 1967; deVilliers, 1974), but we are not sure why a passage is difficult for some individuals to learn and not for others. Since the focus of this paper is on diagnosis, we are interested primarily in those factors which make a given task harder for certain individuals.

The problem of determining what aspects of the stimulus (in this case, the text) cause difficulty is, of course, not necessarily separable from the problem of determining why only certain individuals find a given stimulus difficult. For example, we know that organization facilitates students' general learning (Frase, 1973). It may also facilitate learning more for some individuals than for others. However, as noted above, most of the research on text has not focused on individual differences. In short, the individual interested in translating theory into diagnostic procedures can draw upon relatively few experimental results.

This is not a criticism of research in text. As already noted, many of the structural variations already known to have an effect *across* individuals may be just the variations that account for the differences *between* individuals. Our point is simply that experiments are needed to verify the relation of structural

variations to individual differences. We believe that most of the text processing that accounts for individual differences takes place at one or more levels removed from the direct processing of surface sentences. Processing that takes place at several levels removed will be referred to as *implicit text processing*. We believe the aspects of this implicit processing which account for marked individual differences include both the relative extent and sophistication of the processing.

We will speak of a text as being implicitly and actively processed when the reader generates the fabric which relates sentences to each other and to the larger fabric of which they are a part. For example, two contiguous sentences might stand in the relation of *cause and effect* to each other, and in the relation of *topic* to the paragraph in which they were embedded. The reader who marks these relations is, in effect, creating the fabric which holds the passage together. As noted previously, the possible structure such a fabric might take in memory has recently received a great deal of attention (Anderson and Bower, 1973; Crothers, 1975; Frederickson, 1975). We are more interested in the creation or generation of this fabric or structure than we are in its details.

Although these are not the only aspects of implicit processing which come to mind, four aspects important to the generation of a plausible text structure can be identified: *Prior knowledge, logical skills, systematic integration,* and *active processing*.

The *knowledge* which a reader brings to a passage plays an important role in the processing of text since this knowledge influences the quantity and quality of text processing. For example, the individual who knows that carburetors route gasoline to the engine and that engines will not run on water can get more out of the following passage than an individual without this knowledge.

> *"The car stopped in a hurry. The driver got out and opened the hood of the car. The carburetor was filled with water."*

Though not all individuals will be able to identify the "real" reason for the car's stopping, most individuals will probably infer that the water-filled carburetor had something to do with it. They are less likely to infer that the car's stopping caused the carburetor to fill with water. Again, the most likely inference is based on knowledge which the reader brings to a passage.

The *logical skills* that a reader has acquired can also play an important role in the processing of implicit textual relations. The conclusion that a given pair of sentences stand in a certain relation to each other can often require lengthy and non-trivial deductions. The analysis of the birthday story that follows later underlines the need for various logical skills.

The *integrating* activities which a reader engages in with respect to a given passage can affect the structure that he creates for the text. Relations can obtain between any set of sentences in a text. The reader who takes account of all the information in a text may "understand more" than the reader who processes only the relations between contiguous sentences.

The reader must *act* in those situations which allow for implicit processing. The possession of the required knowledge and logical skills is not sufficient for the generation of text structure. The reader must apply what he knows in the appropriate situations.

In short, the processing of text requires the reader to have the knowledge and skills necessary to supply the relations between sentences, to look for possible relations obtaining between any of the sentences in the text, and to actively process text.

Children have a large store of knowledge and skills which they draw extensively upon in even the simplest of situations requiring understanding or comprehension. The importance of this store is especially clear when one tries to simulate the understanding processes on a computer. The computer does not come ready-made with this store, it must be programmed into the computer. Additionally, the computer does not know when to apply what it knows to what it is reading and trying to understand.

Charniak's work (1969) in artificial intelligence is important because it points out the enormous complexity of seemingly ordinary tasks. For example, consider the following story (Charniak, 1969): (1) Today was Jack's birthday. (2) Penney and Janet went to the store. (3) They were going to get presents. (4) Janet decided to get a top. (5) "Don't do that," said Penney. (6) "Jack has a top." (7) "He will make you take it back."

The story reads quite easily for most people. But let's examine the processing that weaves the separate sentences together.

1. *Today was Jack's birthday.*
2. *Penney and Janet went to the store.*
3. *They were going to get presents.* One might conclude at this point that the presents were for Jack. The reasoning could be that if it is someone's birthday, if no one else's birthday is mentioned, and if presents are mentioned in the story, then the presents are probably for the birthday person. Since we know all three conditions hold, we can conclude that the presents were for Jack.
4. *Janet decided to get a top.* By now one might conclude that the top is a present for Jack, and that Jack is a child. The reasoning is more complicated than it might seem at first. We know that a top can be a present, and we know that if something is a birthday present for someone, we would expect that person to want it for a birthday present. Since we have no reason to believe that Jack would not want a top, we can conclude that he would, in fact, want it. Now we know that if someone would want a top for a birthday present, that someone is probably a child. Therefore, we conclude that Jack is a child.
5. *"Don't do that," said Penney.*
6. *"Jack has a top."* One might conclude here that Jack would not want a second top. If Penney had not said, "Don't do that," we would be less apt to reach this conclusion. Therefore, "Don't do that" must have affected our reasoning. One possible way of arriving at this conclusion is as follows: Jack has one top. If Janet buys Jack a top, Jack would have two tops. He might not want the second top if someone suggests he own only the first. By suggesting that Janet not buy Jack a top, Penney suggests that he own only one. Therefore, Jack might not want the second top.
7. *"He will make you take it back."* The *it* in this sentence refers to the second top. We can confirm that the *it* refers to the second top by asking if the sentence makes sense. People are asked to return a thing they have just bought for someone only if that person does not want it. It can be inferred from the previous sentence that Penney believes Jack does not want a second top. Therefore, Jack's asking Janet to take back the second top makes sense. It makes sense because Janet would be getting something that Jack did not want, and because Janet would have to return the top if Jack really already owned one. In short, not only does Penney's statement make sense, it makes sense in context.

The preceding analysis bears out the need for (a) a *knowledge* of facts beyond those presented explicitly in text, (b) various *logical skills*, (c) considering the impact of information throughout the story on the *interpretation* of any given sentence, and (d) *active participation* on the reader's part. We turn now to a discussion of the work that should precede diagnosis of text processing difficulties in reading comprehension.

One place to look for the presence of the four factors discussed above is on existing tests of reading comprehension. Using present tests of comprehension has a certain appeal. Many of the tests accepted as valid measures of comprehension should be analyzed to see where the above factors operate, and their effects analyzed to see if they are predictive of an individuals' reading comprehension performance. It may be the case that more conventional measures of comprehension (such as present tests of reading comprehension) do not tap these factors. The birthday story clearly requires them. Implicit processing may be very important to the understanding of most texts, even though it is never tested on conventional measures of reading comprehension. This line of reasoning argues for an analysis of the materials students are confronted with; we want to find out if understanding the materials depends on these four factors.

What are some of the obstacles that study of these factors need to contend with? Consider the case of knowledge: How should one go about identifying everything that, for example, the average third grader knows? Something such as this may well be required if we want our measure to sample from a "complete" pool of knowledge, otherwise generalizations about the extent of a given knowledge deficit are unwarranted.

There is another problem that should be solved before we measure the importance of "general knowledge:" A person's knowledge base could be inadequate either because the person does not have the necessary facts, or because the person does not generate the necessary facts from an adequate store. For diagnostic purposes, the above distinction is crucial. Consider the case of logical skills. Reasoning in natural language is not easily translated into terms and relations used in formal logical models (Minsky, 1974), nor is it necessarily psychologically appropriate to do so.

This outline of influences on the implicit processing of text can serve as one starting point for the analysis and development of diagnostic measures of text comprehension. It can serve as one way of conceptualizing and "compartmentalizing" the analysis of texts and tests encountered by readers.

WORD PROCESSING

In this section, four influences on word processing are discussed: *decoding, partial processing, encoding,* and *production*. Word processing as used in this paper will refer to the activities and information necessary to go from print to meaning (*decoding*). We can think of the print-to-meaning translation as a process involving at least two steps: (a) that information in the visual display which is needed to retrieve the meaning associated with a word must be *encoded* and (b) the meaning associated with the word must be *retrieved* and appropriately *interpreted*. We turn now to a discussion of those factors which operate in, and influence the translation of print to meaning, and we point out the relation between each factor and comprehension.

Decoding

Decoding refers to a broad range of activities or processes (see Gibson and Levin, 1975). Various factors contribute to decoding speed and accuracy. Many of these factors can be improved ("developed," "remediated") although there is considerable disagreement about how best to do so (Chall, 1967). At the extremes, decoding speed and accuracy bear clear relations to comprehension. leaving a large middle ground unaccounted for. For example, we cannot presently say whether decoding three out of every 10 words incorrectly will significantly affect an individual's performance on comprehension tests. Nor can we say how fast a reader must decode, given that the reader has a limited time to complete a comprehension test. Clearly, the reader must have enough time to read the question, read the relevant material, and read the possible answers. But just reading all the required material in the allotted time is not enough, for unless the question is very simple, some time must be devoted to thinking about the possible answers. Decoding is not an activity which always takes place apart from higher level influences, hence, when we refer to "decoding activity," we refer specifically to that aspect of the print-to-sound translation which is independent of higher level influences. The importance of a sensitive diagnostic instrument becomes more clear. It exists to identify decoding errors in a situation where other influences contribute to the word recognition process.

Partial Processing

Two characteristics of partial processing stand out (see Samuels, Dahl

and Archwamety, 1974; Goodman, 1969): (a) readers seem to actively process information--they make predictions about words and phrases to come on the basis of existing syntactic and semantic information and (b) readers scan the visual display for information which suggests (but does not necessarily confirm) a prediction. This is a dynamic process--the two characteristics continually interact. The information from the visual display both helps to determine, and is itself determined by, the prediction.

Misinformation is sometimes the consequence of such a process. A prediction may be selected on less than sufficient evidence; a word is "seen" which was not on the printed page. For example, a student might read, "The athlete sprinted around the trail," as, "The athlete sprinted around the track." The reader in this case might have predicted the occurrence of the word "track" on the basis of preceding syntactic and semantic information. The reader failed to correct the mistake because a partial scan of the visual display confirmed the visual similarity of the word on the page, "trail," to the word expected, "track." Partial processing is not restricted to the identification of only those words occurring in context. A reader can make an educated guess at a word in isolation even without preceding syntactic and semantic information. In isolation, the reader can use the information in the first part of a word to make an educated guess as to the last part of the word. Many incorrect predictions coupled with the acceptance of less than sufficient information can lead to low test scores.

Encoding

Encoding problems also exist. Encoding in word processing is the translation of the printed stimulus into whatever form it takes when deposited in memory. This form may include both surface and semantic information (Begg and Wickelgren, 1974; Clark and Card, 1969; Fillenbaum, 1969; Sachs, 1967). Sometimes a word, after it has been decoded, is "automatically" translated into another word. Evidence for such errors comes from the presence of certain miscues during oral reading (Goodman, 1976B). Goodman reports that one child he studied consistently read *train* as *toy*. The mistake was specific to the *train-toy* translation. That is, the child did not decode other words beginning with *t* as *toy* (except for *toy* itself). Therefore, neither decoding nor partial processing seemed to be the determining influence.

Production

There are two kinds of production errors: First, they reflect temporary production problems. Spoonerisms are a case in point (Fodor, Bever and Garrett, 1974). Some spoonerisms involve full word exchange like "I batted my brick against the headwall" while others reflect affix and stem movement where "He made a lot of money intelephoning stalls" (Garrett and Shattuck, 1974). The source of the above errors, unlike decoding, encoding, and partial processing, is not necessarily part of the perception process. It is believed that they reflect the production process (Fodor et al, 1974). However, since the measure we use for testing perception includes the production of verbal responses, we need to be aware of the presence of production-related errors. Spoonerisms are not the only errors of this type. More permanent production errors will appear in the child with speech problems. Speech problems can influence reading comprehension in those situations where the child arrives at the meaning of a word through the intermediary of sound.

Diagnostic Procedures

The following diagnostic procedures are designed to separate errors in the translation of print to meaning into the above four categories. The set of diagnostic procedures outlined below (see Figure 1 p.30) requires three related

sets of materials: (a) reading comprehension tests, (b) listening comprehension tests, and (c) vocabulary tests. The reading and listening comprehension tests should be representative of the various subject matter that teachers wish to test. The material should be graded for reading difficulty with respect to *each* skill used to measure understanding. While it is reasonable to assume that some material will be easy to understand if a fairly simple skill is required to evidence comprehension, the same material will become more difficult to understand if a more complex skill is required. The vocabulary tests would draw upon the words in the listening and reading material.

The procedures needed to identify decoding, partial processing, encoding, and production errors include the administration of certain measures or tests: (a) a vocabulary measure, (b) a reading-comprehension measure, (c) a listening-comprehension measure, and (d) a decoding measure. Most of the measures are intended to serve as "filters." That is, they should separate those individuals who do from those individuals who do not require further diagnostic work. In particular, the measures are designed to identify those individuals with potential word processing problems.

The rationale behind the testing sequence is to remove from consideration those individuals with obvious vocabulary problems. Vocabulary difficulties can contribute to both word and text processing problems. Therefore, all individuals should be given a vocabulary measure before being administered the reading-comprehension measure. Individuals with vocabulary problems should be excluded from further analysis until the vocabulary problems are remediated.

The remaining students should be given the reading comprehension measure. The grade level of the materials should correspond to the grade level of the students. It is important for later analyses that the oral miscues (Goodman, 1976B) of the readers on the reading comprehension measure be recorded. Students who perform at or above grade level on the reading comprehension measure need not be given any of the remaining tests. Students performing below grade level may be having difficulty for a variety of reasons. Word processing problems are one possible cause of poor performance.

Students scoring at grade level on the listening-comprehension test and below grade level on the reading-comprehension measure may have word processing difficulties. Students scoring below grade level on the listening comprehension test and still lower on the reading comprehension measure may have a combination of word and text processing problems. The extent of the word processing problem can be uncovered by procedures such as those suggested below. The remainder of the students with reading comprehension scores below grade level will score at or below their reading grade on the listening comprehension measure. Those with similar reading and listening scores have few if any word processing problems. These students should be given diagnostic measures such as those suggested in the section on text processing.

How do word processing errors affect comprehension problems? Again, the individuals in the group selected for further diagnosis at the word processing level should have reading comprehension scores below grade level and listening comprehension scores which fall above their reading level. See Figure 1 on page 30 for a diagram of the series of diagnostic measures and procedures discussed. It shows the measures needed to identify those individuals with potential word processing errors (steps one through seven). Following are the procedures needed to identify particular instances of word processing errors, as well as the cause of a given error.

Oral miscues should be recorded at the same time the reading comprehension test is administered. (We assume that these oral miscues are representative of word processing errors the child makes while reading silently.) It is important to look at the subset of word processing errors that bear a clear relation to comprehension. For example, a *not* may have been missed, or *tallest* read as *shortest*. Having identified word processing errors which bear a clear relation

to comprehension problems, it is necessary to identify the source (i.e., decoding, partial processing, encoding, or production) of these errors. Since we are most interested in identifying and separating the decoding from the partial processing errors, it is necessary to remove those errors due to encoding and production problems from consideration.

This requires the administration of an additional measure. A list of words should be drawn up specific to each student. The list should be composed of all words for which miscues were recorded. Each child should then be presented with the list of those words (the decoding measure, step 8) on which he made word processing errors. The subject's miscues should again be recorded. The diagnostician now has two lists of miscues made to the same set of words. One set of miscues was made on the reading comprehension measure. The other set was made on the decoding measure. These lists will form the basis for the identification of various error sources.

The identification of encoding errors will require some additional probing. The *train* and *toy* confusion suggests the sort of probing that is needed. First, we note that *train* is consistently decoded as *toy*. Second, we note that *toy* is not confused with other words similar in sound or shape to *train*. Therefore, we can infer that the child recognizes the word *train* as distinct, though it is still encoded as *toy*. We already have a list of those words which were spoken incorrectly at least twice. Certain of these words may represent repetitions of the same decoding error. Others may represent encoding errors. To separate encoding from decoding errors, it is necessary to know whether a child makes similar errors to other words which are similar in sound and shape. In short, *encoding errors are those miscues which are consistently repeated with the same word and which are specific for a given word.* Production errors must also be separated out. The diagnostician should be able to identify miscues due to speech problems.

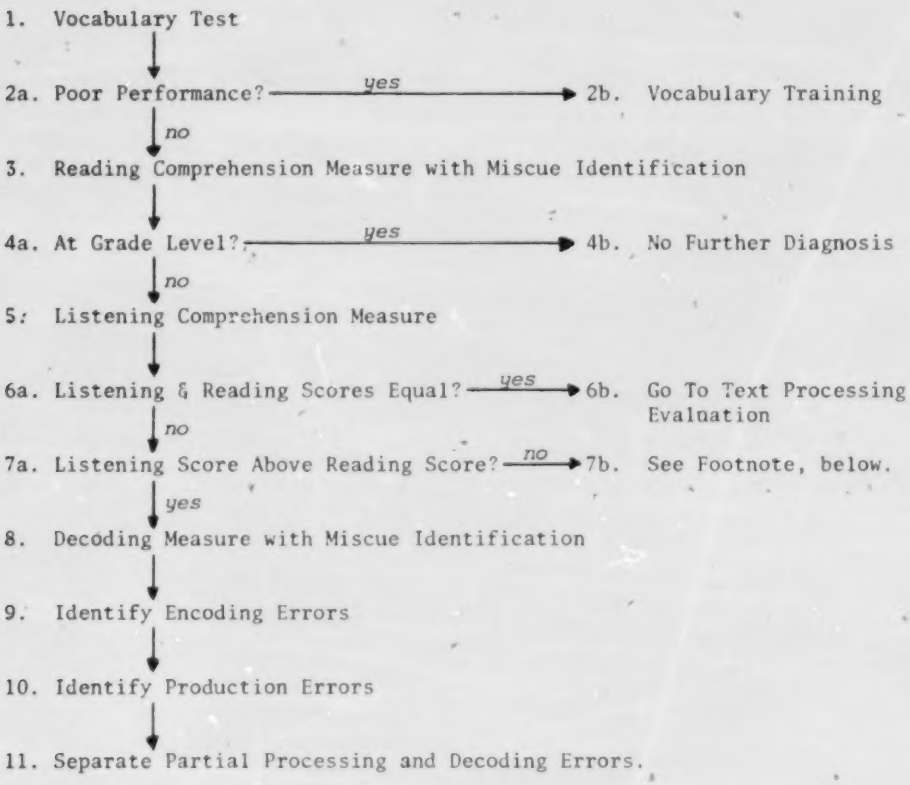
The remaining miscues from the reading comprehension test may be the result of either partial processing or decoding problems. The list of miscues from both the reading comprehension and decoding measures should be compared. Some words will have been incorrectly processed on the reading comprehension measure, but correctly processed on the decoding measure. We can infer with a fair degree of confidence that these words represent partial processing errors. However, not all of the remaining errors represent decoding problems. Remember that words can be partially processed even when they are in isolation. The reader can guess at a word before seeing the entire visual display. To identify a given error as a decoding error, it is necessary to verify that the reader has seen the entire visual display (all the letters in a word). For example, we need to know that the child who reads *pat* as *pan* has seen the *t* in *pat*. To make sure this is indeed the case, the diagnostician might ask the child to spell a word as it occurs on a page before pronouncing it. If the child still mispronounces the word, the error can be attributed to decoding problems. A profile of those errors clearly resulting in comprehension problems would now exist for each child. This profile is useful for remedial purposes.

We must also consider the effects on decoding comprehension of decoding speed. Some incorrect answers to questions on the reading comprehension test will have nothing to do with the fidelity of a print-to-sound translation. Some of these errors may arise because individuals must spend too much time decoding. Reading too slowly can be just as detrimental as reading too quickly. Smith (1975) suggests that many reading comprehension problems are the result of too much attention to detail. Also, the questions asked of the reader as well as the difficulty of the materials can influence reading speed, and the time allotted an individual to finish materials can determine the relative effectiveness of a given reading speed.

For any given time spent looking at a word embedded within a sentence, slow decoders must spend more time decoding and less time integrating information

than fast decoders. "Integrating" is a term used to refer to that activity which involves thinking about a word's meaning, and the relation of this meaning to the meaning of preceding context. Decoding which has not reached a certain speed and independence of attention (LaBerge and Samuels, 1976) can outstrip the capabilities of short-term memory. Time is a factor because information in short-term memory which is not rehearsed fades quickly (Peterson and Peterson, 1959). A skill can proceed so slowly that information acquired earlier in a sentence or text has disappeared from memory by the time it is needed for higher level processing.

Figure 1



Outline of Diagnostic Procedures

A few individuals may score lower on the listening comprehension measure than on the reading measure. Of course, it is not necessary for an individual to score lower on the listening measure than on the reading measure for there to be a special problem with listening. We should separate out those students with "special" listening problems before we administer the listening comprehension measure.

Language Development: Universal Aspects and Individual Variation

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Discussion in this paper will center on some universal trends and individual variations that have been observed in the language development process. Since language development is a rather huge topic, this paper will present some examples of these universal trends and individual variations during the early years of life (Menyuk, 1972).

Universal aspects of development and individual variations have been observed at the very earliest stages of development. The age at which a child begins to use recognizable words and structures varies widely. There is evidence that the surface form of these early structures can vary, although these differences have not been carefully documented and described. Some children begin language production by primarily using single words that are clearly articulated while others use phrases that are difficult to comprehend (Nelson, 1971). In addition, the function of the language usage appears to be different for these two groups. The single word producers appear to use language to *name* things in the environment, while the latter group uses language to express needs and feelings. Such differences may be due to the birth order of the child, or to differences in the linguistic styles of the mothers in their verbal interactions with their children.

Differences in the mothers' styles may result from whether or not the child is a first or later child, or to the mothers' levels of education. In any case, how these differences in the earliest productions of language can affect the course of later development is not clear. Both groups of children use language for both functions. They differ only in *proportion* of usage. An intriguing possibility is that these differences are early indicators of different conceptualizations about the *use* of language. These conceptualizations could, logically, strongly influence the course of later language development, and could do so especially in those situations where language usage is removed from the usual direct speaker-listener communication as it is in reading.

Despite these variations in the phonological form and use of early utterances, the sequence of development of structures that has been found reflects both the universal functions of language and the child's ability to capture the universals in his language use. At the very earliest stages of development, when he is primarily producing one word utterances, the child uses language in accompaniment to an action in a particular situation to declare (either descriptively or emphatically), to demand, and to question. In addition to the situation and action which help to make clear the meaning of these utterances, he uses a purely linguistic device--intonation and stress-which clarifies their meaning. These one-word utterances may describe a relationship, but the listener must rely on the situation to interpret the relationship the child wishes to express (Bloom, 1970).

Once the child begins using two word utterances, he can describe relationships more precisely by using certain word items in a particular order and by using intonation and stress. He not only has a "topic" of conversation, he also has a "comment," and this "comment" modifies the "topic (Menyuk, 1969)." Several factors about these early developments should be noted. First, the child uses some linguistic conventions (intonation and stress) and content words to define meaning even at a very early stage. Second, the meanings he conveys fulfill some basic functions of language: to declare, to question, and to demand. Third, each convention he adds allows the child to convey meanings in his utterances that are increasingly precise and he does this with increasing independence from the situation. That is, those aspects of human language which may make it unique--to

talk about things that are displaced in time and space, to hypothesize, and to invent (Hockett, 1963)--are increasingly evident in children's utterances.

From the stage at which the child is using one and two word utterances until he reaches some leveling-off stage of grammatical development, he continues to add structures to his grammar. The order in which he adds these structures is dependent on several factors. Structures which involve the *addition* of items are acquired before those which involve the *movement* of items. Thus, for example, negative structure rules are used before question structure rules. Structures which are simpler in derivation are acquired before those that are more complex. Thus, for example, negative sentences are used in their full grammatical form before negative-question sentences (Brown and Hanlon, 1968). Rules which operate on a small domain are acquired before those which operate on a large domain. Thus, number agreement is evidenced within a noun phrase before it is evidenced within the sentence (Cazden, 1968), and in the latter before it is evidenced across sentences (Menyuk, 1969).

Rules which describe concrete relationships are acquired before those which describe abstract relationships. Thus, for example, prepositional phrases which describe place are used before those which describe time (Menyuk, 1971). Increasing complexity in language production cannot be equated with increasing sentence length or gross language output. Complexity is a multifaceted influence on the sequence of acquisition of grammar. It consists of *types of operations* required, *number of operations* required, the *domain of application* of the rules, and the *concreteness of relationships* expressed by structures. These facets overlap so that several are operating simultaneously.

The child's ability to add structures to his grammar indicates that he is able to make generalizations about the language he hears. For example, he makes generalizations about what composes a negative, imperative, declarative, or question sentence. At different stages of development he makes different generalizations about the composition of these sentence types. It should be stressed that these parameters are not specifically pointed out to him. He selects them spontaneously. The generalizations he does make are dependent on those aspects which are most important to him and the level of analysis he can achieve within the limits of his own memory and cognitive capacities.

The *sequence* in which various types of structural descriptions are acquired is very similar for children within the same language community during these early stages of development. This sequence is similar for children from widely different language communities, although probably very similar cultures. It is reasonable to expect universal aspects in this early developmental period, since (a) children do not differ widely in their neurophysiological capacities if they are physically and intellectually normal, (b) there are universal categories and relationships which are expressed in many languages (Greenberg, 1963), and (c) the uses of language during this early period seem to be quite similar for children from similar cultures.

By the time the child enters school, he has a vocabulary of 2,000 to 3,000 words or more. He uses all the major syntactic categories of sentence, subject and predicate, verb, noun, pronoun, determiner, adjective, adverb, and preposition. He can generate declarative, imperative, negative, and question sentence types, and he can generate them in the active and passive moods. He uses markers of number, place, time, manner, and possession. He can conjoin and embed sentences--and thus, theoretically, has achieved the ability to create indefinitely long sentences. He can express the logical notions of actor-action-object, of negation, of conjunction, of cause and effect, and of equality. Although this has been accomplished by the end of the preschool period, the child continues to develop his linguistic skills for sometime. These further developments are important because they lead to much greater precision in language use than was achieved during the early stages of development, and they allow the child to hypothesize and conceptualize about his experiences in a much fuller manner than he did previously.

Although the child at the end of the preschool period can generate new sentences by embedding one into the other, the contexts and forms in which he does this are quite limited. He embeds sentences with only certain verbs and only at the end of other sentences. For example, he produces sentences such as *I know what he's doing* and *I see the store that's on the corner*, but not sentences such as *It seems that he's the wrong boy* or *The store that's on the corner has a sale*. Although he produces noun phrases, he elaborates them only to a certain degree. For example, he produces sentences such as *The old man was mean and he hit the boy*, but not sentences such as *The mean old man hit the boy*. His tense markers are limited, and he rarely expands the verb phrase by adding markers to the verb. For example, he produces *I was playing* but not *I have been playing*. He persists in trying to maintain the subject + verb + object order. Therefore, he does not use structures which disturb this order or intervene for too great a length of time between the occurrence of the subject and the verb.

The most important linguistic development from kindergarten on is the acquisition of more and more complete descriptions of relationships within and between sentences. These more complete descriptions require the addition of properties to the definition of words and these properties are syntactic and semantic. At the kindergarten stage the child's knowledge of these properties is limited. For example, although the child in most instances appropriately uses prepositions in phrases, his comprehension of these prepositions and of the structures they can go with, is limited. He may substitute one preposition for another as in *She took me at the circus* and *I wake up on the morning* or he may use the preposition in a limited way. His use of the preposition *with* indicates only the meaning of accompaniment (*I want to go with him*), and not the instrumental meaning (*I broke the chair with my foot*). The child's use of verbs in sentences shows the addition of syntactic and semantic properties--and this indicates growth in his comprehension of the meaning and function of words.

As he adds properties to his readings of verbs, restrictions are found on the words that co-occur in a sentence. For example, at one stage of development the verb *make* is used in all contexts of *to form* and, therefore, in the context of both +human and -human (*make a team* and *make a box*). The verbs *say, tell,* and *ask* share properties so that sentences such as *say the story* and *tell the question* occur frequently in preschool and kindergarten language samples, but rarely in the language samples of older children.

Not only is the child adding to the syntactic and semantic components of his grammar after he enters kindergarten, he is also adding rules to the phonological component of his grammar. These are primarily consonant cluster rules and morphological rules. Morphological rules that can be applied in a limited number of contexts are acquired after those that apply most generally. Thus, plural markers are acquired in the following order: *+z* as in *bees, +s* as in *bats, +Iz* as in *matches, +voice+z* as in *wolves,* and *irregulars* as in *mice*.

The same factor of increasing specificity operates in the sequence of acquisition of present and past tense markers. Children begin to expand their dictionaries to include many more multisyllabic words and, thus, to learn the rules for application of suffixes and stress to generate new classes. For example, they learn that stress on the second syllable converts noun to verb (*áddress* versus *addréss*) and that the addition of suffix plus change-in-stress converts verb to adjective (*télegraph* versus *telegráphic*). Some eight- to 10 year-old children apply appropriate stress rules to nonsense material in much the same manner as adults do. Interestingly, however, there are large individual variations among children so that some older children cannot carry out this task.

Just as with the earlier stages of development, there seem to be universal trends in later development. The sequence of acquiring increasing numbers of properties of words, comprehension and expression of relationships within and between sentences, and acquisition of phonological rules seems to be similar for a large number of children at this later stage of development. However, there clearly are individual variations as well, and these seem to become more marked during the later stages of this early development.

During the developmental period from about 18 months to five years, the child radically alters the content of his grammar, at least as evidenced by his language production. His analysis of the linguistic data he hears seems to change as well, although he appears to *understand* a great deal about the structures before he *produces* them in his own sentences. The exact differences between comprehension and production at various stages of development have not been described. When the child is producing one and two word utterances, there is some indication that he only comprehends the meaning of the words and relationships expressed in his own utterances. Thus, comprehension and production are closely related.

However, the more advanced children at this same early age of development (those producing two and three rather than one and two word utterances) can comprehend sentences that are more complex than those they produce (Shipley, et al, 1969). Perhaps those children who initially exhibit a greater distance between production and understanding continue to show this distance at an ever-increasing rate as they mature because they are capable of a deeper analysis of the structure of a sentence. Thus, such children more quickly acquire more complicated structures. This is a speculative comment. Although the *sequence* of acquisition is similar for children within the same linguistic community, different children acquire structures at different rates.

Different children may approach asympote in acquiring new structures at different levels of analysis of the structure of sentences. By the time the child enters kindergarten, he seems to understand some quite complicated structures that he never, or only rarely, uses. There are limits to the understanding as well as limits to the structure of utterances that are produced. Structures which involve transformational operations that disturb the subject-verb-object order are difficult for him to interpret and these structures continue to be difficult for some time.

The child entering kindergarten produces conjoined sentences that express logical relationships, but he comprehends and uses conjunctions which do not place many restrictions on conjoined elements (*and*) or those which reflect concrete cause and effect relationships (*because*). He rarely uses and does not completely comprehend the conditional (*if, so*) (Menyuk, 1969) or antithetic relationships (*but*) (O'Donnell, et al, 1967). Children express and understand causal relationships before temporal relationships (*when* and *while*), temporal-simultaneous relationships before temporal-sequential relationships (*before* and *after*), and temporal relationships before the antithetic relationships (Katz and Brent, 1968).

At a still later stage of development, he comprehends some structures in which the subject is separated from the verb by the object (*I promised him to go*), but different children vary widely in this ability, perhaps depending on their cognitive development and language experience (Chomsky, 1969). Some structures of this type are not comprehended by adults in the community. Coincidentally, it has been found that almost 50 percent of American adults never reach "adolescence" in the Piagetian cognitive sense (Kohlberg and Gilligan, 1971). Thus, different structures may be "available" to different children at various stages of development, and there are some structures that may *never* become available to certain children in their sentence analyses.

Individual differences in the level of language analysis at the time of entering school may produce differences in the acquisition of reading and writing skills. Although there are no conclusive data which indicate that this is so, it seems logical. There are, after all, a great many similarities between the two language systems to be acquired. There are rules for sentence formation which are similar in both systems, and acquisition of the two language systems requires the capacity to generalize, abstract, and store information that is hierarchically structured as sentence, phrase, word, and segment. The lack of data on the relation between these two processes may be due to the ways language development and reading acquisition have been measured in studies that have attempted to measure

correlation between these two kinds of language performance, rather than to the lack of actual correlation.

There are, then, both universal trends and individual variations that can be observed in the child's acquisition of language. The universal trends reveal themselves as fairly fixed sequences in the acquisition of basic structures of the language. They probably result from constraints imposed by maturation of the neurophysiological and cognitive capacities of the child, the functions of language, and the structure of the system he is acquiring. The individual variations reveal themselves as differences in the rate at which various structures are acquired by children and in the different levels of analysis of the language that are reached. These differences are probably due to particular language experiences and/or intellectual capacities.

Dialect variation and bilingualism play an important role not only in the use of language but also in the child's conception of language function. Both universal trends and individual variations should be considered when planning for the child's acquisition of reading. The universal aspects indicate why and how a child goes about acquiring a language system. The individual variations may prescribe his level of competence at the time of school entrance or where he is "at" at the beginning of the reading acquisition process, and his conception of the functions of language.

Developmental Psycholinguistics: Implications for Reading Research

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This paper is divided into three sections. The first identifies two recent milestones in developmental psycholinguistics. These milestones are Brown's (1973) synthesis of research in this area and Söderbergh's (1976, 1977) application of research methodology from developmental psycholinguistics to the study of reading acquisition. The second section of this paper discusses a research strategy--the application of research methodology from developmental psycholinguistics to the study of reading acquisition, following Söderbergh's model. The third section of this paper, like the second, suggests a research strategy to deal with the types of perceptual units used by readers to comprehend written language.

TWO MILESTONES

Two recent milestones in developmental psycholinguistics are also milestones for reading researchers and teachers.

The first recent milestone is the publication *A First Language*, which is Brown's (1973) synthesis of research on language development. He points out that the most important source of information for anyone studying language learning is the errors made by the child. Similarly, the reader's errors provide an important source of information for the teacher as has been demonstrated by Goodman (e.g. Allen and Watson, 1976; Goodman, 1973, 1976A, 1976B), and by others--e.g. Clay (1968) and Weber (1968).

A "new" direction that Brown sees in developmental psycholinguistics is concern for meaning. He points out that the first analyses in the 1960s of child sentences were in terms of pure syntax, in abstraction from semantics, with no real attention paid to what the children might intend to communicate. There is an important implication here for reading research: Since the foundations of reading are in language, reading researchers and reading teachers need to carefully assess their individual positions on the role of meaning in reading. Is "meaning" a taboo word in the reading classroom (see Gleitman and Rozin, 1972; Goodman, 1972)?

Brown discusses the "construction rules" that children use to synthesize and analyze language. He points out a research study suggesting that, in language acquisition and development, "construction rules" do not emerge all at once at the levels of spontaneous use, discriminating response, and judgment. The speaker uses various construction rules to move between speech and meaning. Similarly, the reader uses various construction rules to move between writing, on the one hand, and speech, language, and meaning, on the other hand. One must not assume that the reader develops the skills for making conscious judgments about whether or not particular construction rules apply at the same time that he develops the skills to spontaneously use a particular reading construction rule. It has been suggested that written English be thought of as one dialect of spoken English. Being able to use the construction rules of this particular "dialect" is very different from being able to make conscious judgments about this "dialect." The implication for teaching reading is that, for the child, the process of spontaneously using reading construction rules is different from the process of making conscious judgments about the application of such rules. What might be the implications of this for research on teaching reading without having the child deal consciously with rules?

Developmental psycholinguists are searching for universal aspects of language development, but they are conducting in-depth analyses of individual children. This has important implications for reading, for it suggests that one can gain an understanding of literacy acquisition, and of impediments to literacy acquisition, by studying and working with very small numbers of individual children. The massive and expensive First Grade Reading Studies with their large numbers of students did not tell how reading is acquired or impeded. But, like the developmental psycholinguists, one can find out by studying individual children. This can be done by researchers and by teacher-trainers, but far more importantly, it can be done by in-service and preservice teachers to further refine their skills in observing advances and impediments in reading acquisition.

I would like to argue that current theory in developmental psycholinguistics has the following major implications for reading theory and practice: (a) The relevant unit in reading is not the distinctive feature of a letter, not the grapheme-phoneme correspondence, not the word, not the sentence, but the individual reader (interacting, of course, with an individual teacher). (b) Teachers and prospective teachers should begin doing reading diary studies (following the models of the developmental psycholinguists). Teachers cannot, of course, study every child, but a teacher can study--in depth--one, two, or three children, and the insights that teachers have about learning to read can be increased. Teachers would be far ahead of researchers in this regard; researchers simply do not have clear, comprehensive descriptions of how reading is acquired.

Such reading acquisition studies would have immediate payoff for teachers who could gain invaluable and otherwise totally unobtainable information about their students and about their teaching. The diary studies would be an integral part of a diagnostic-prescriptive approach--an integral part of teaching.

A second recent milestone in developmental psycholinguistics is also a major milestone in theory and methodology for reading researchers and teachers. It is a reading diary study by Söderbergh (1976) which deals with a Swedish-speaking child learning to read, and is entitled *Reading in Early Childhood: A Linguistic Study of a Swedish Preschool Child's Gradual Acquisition of Reading Ability*. The author is a linguist, and her approach is based upon developmental psycholinguistic models. Her work yields both a richness of detail and a number of tantalizing generalizations about the learning-to-read process.

This landmark study, carried out by a linguist, provides conclusive evidence of the applicability of current theory and methodology in developmental psycholinguistics to reading. Here, one finds the descriptive orientation of the language researcher and the prescriptive orientation of the reading teacher merged into an enlightening discussion of reading acquisition. The top information need in reading is gaining an understanding of how literacy is acquired (Durr and Wanat, 1973). Those most competent to gain this information are classroom teachers working in partnership with language specialists.

RESEARCH STRATEGY 1: THE READING DIARY STUDY

Questions and Procedures in Reading Diary Studies

Following are some general guidelines for a reading diary study. A major goal of such a study is to provide detailed information on the reading acquisition processes of a small number of children. The children can be taught individually or as a group. Teaching approaches to consider are the "whole word" or "language experience," among others. A "whole word" approach as described by Doman (1963), was employed by Söderbergh (1976) and by the Steinbergs (D. Steinberg and M. Steinberg, 1975) in their reading diary studies. As the reading diary study progresses, extended passages and books can be read, and the child's comprehension skills when working with increasingly larger blocks of text can be studied. The teacher maintains detailed records of all of the words shown to the child and all of the child's responses. The information to be analyzed includes what the child

has mastered, what the child errs on, and the types of word-attack and later, of course, sentence-attack, and paragraph attack strategies that are observed. In her detailed diary study, Söderbergh (1976) identified five categories of responses: (a) no response; (b) whole-word substitution, in which the child mistakes the new word for a previously learned word; (c) adjunctions, in which the child adds together two previously learned word parts; (d) deletion, in which a part of a previously learned word is deleted to create a response for a new word; and (e) word-part substitution, in which part of a previously learned word is substituted for a part of a new word. Changes in the percentages of occurrence of each of the five response types over time would provide information about developments in the child's linguistic-cognitive-perceptual strategies for making sense out of written language. Computer data-processing programs can save time in identifying patterns of relations between the child's correct or incorrect response to a particular stimulus, on the one hand, and the occurrence of these spelling patterns in the child's history of stimuli and responses, on the other hand.

In addition to classifying the children's responses into these five categories, attention needs to be paid to the types of perceptual units that children use as they learn to read. Questions dealing with perceptual units include: (a) What letter groups does the child treat as perceptual units? (b) What is the order of acquisition of these letter groups? (c) Once the child learns to use a particular letter group as a unit, does the child experience any lapses in his mastery of this unit? If so, what are the related factors? (d) What is the nature of the child's progression in mastering these perceptual units? (e) What is the progression over time in the size of the perceptual units used by the child? (f) What are the relations among letter groups that are mastered at the same time--are highly similar groups more likely to be learned at the same time, or are highly dissimilar groups more likely to be learned at the same time? (g) Are certain letter positions, like first letter and last letter, more critical cues? Does the importance of letter position as a cue increase or decrease over time? (h) How important a cue is word length? Does its importance increase or decrease over time? (i) How many letters do the error and the stimulus have in common? How does this percentage change over time? (j) Is the order of the shared letters in the error the same as the order of shared letters in the stimulus? How does this change over time? (k) Are the shared letters grouped together in one part of the word, or are they spread throughout the word? How does this change over time? (l) Do different syntactic and semantic categories differ in their error rates? How does this change over time?

Reading Diary Studies as a Preservice Tool

Farr (1974) had identified the development of strategies to help teachers to become better observers of learning processes in children as a major goal in teacher education. The reading diary study should be a highly effective tool for improving the teacher's observation skills. Its effectiveness in this regard should be assessed. Also, Venezky (1974) has pointed out that a major weakness of teacher training programs is their failure to train teachers to follow through over an extended period of time with a complete instructional sequence. Existing teacher training programs generally neglect to provide their students with directed experience in tailoring instruction to individual learners' needs. The reading diary study should be a highly effective tool for developing the teacher's follow-through and individualization-of-instruction skills. His effectiveness in this regard should be assessed. Finally, the reading diary study as a preservice tool is a learning experience preferable to the *excessive* theorizing, hypothesizing, and fantasizing about reading acquisition processes that may occur in preservice teacher education programs.

Reading Diary Studies as an In-Service Tool

The need for teachers to become better observers of learning processes in individual children, the need for teachers to increase their ability to follow through with a complete instructional sequence, the need for teachers to become better individualizers, and the need for more concretizing about reading acquisition processes can be addressed in an in-service context as well as in a pre-service context. The experienced teacher in the classroom certainly does not have the time to develop detailed diary studies of each child, but she does have time to develop studies of one, two, or three. As the teacher becomes more experienced, more and more children can benefit from this close observation of learning-to-read activities.

A critical mass of studies describing reading acqusition in typical learners is lacking. The development of these descriptions is the most needed information in reading. Reading diary studies, based upon the models of the developmental psycholinguists, are the most promising tools for obtaining this information.

RESEARCH STRATEGY 2: RELATIONS AMONG LINGUISTIC CHARACTERISTICS OF TEXTS, READERS' COMPREHENSION, AND READERS' LINGUISTIC BACKGROUNDS

Minority groups are disproportionately affected by reading comprehension problems (Coleman, 1966; Miller, 1974; National Assessment of Educational Progress, 1972). Individual differences in such factors as selective perception may interact significantly with success in learning (Grimes and Allinsmith, 1961). Current theories attempting to describe the processes of mature reading and how reading skills are acquired, have failed to take into account possible group or individual differences in the perceptual strategies that readers use to extract meaning from written language (Gibson, 1972, 1974; Gibson and Levin, 1975; Levin, 1974; Miller, 1972; Neisser, 1974A, 1974B; Wanat, 1971).

Since minority groups are disproportionately affected by reading comprehension problems, the perceptual strategies (the sentence-attack and paragraph-attack skills) of students with various characteristics (e.g., bilingual vs. bidialectal vs. school-English-only speakers) should be studied to determine if there are significant group or individual differences in their perceptual strategies. If such differences exist, then the current approach of researchers trying to develop and test theories, models, and descriptions based upon the notion of an "idealized reader" is wrong. If such differences exist, then current programs of reading instruction for bilingual and bidialectical groups, for example, will have to be changed to be sensitive to, and build upon, the perceptual strategies that these individuals bring to the learning-to-read task. What is needed is a fresh approach to the analysis of the reading problems of low-achieving students--an approach that studies the linkages between language patterns, perceptual strategies, and reading problems--employing valid and reliable measures. "The reader must be selective--it doesn't matter how much information enters the visual system, he can get only four or five items through the processing bottleneck into short-term memory. So, in addition to being fast, he must choose the four or five items that will best meet his information needs (Smith, 1971)." Also, eye-fixation studies show that skilled readers selectively allocate their attention to linguistically defined areas within the text (Comunale, 1973; Wanat, 1968, 1972, 1976A, 1976B; Zargar, 1973).

Thus, fluent adult readers selectively allocate their attention to areas of the sentence. Smith (1971) states that the reader must be selective in what he attends to. Is the ability to *selectively* attend to particular linguistically defined areas within sentences a critical factor in the development of reading skills? At present, we do not know. Do high-achieving readers differ from low-achieving readers in the ways they selectively attend to areas of the text? We do not know. Since the reader's knowledge of language structure plays a central role in guiding his search of the text (Wanat, 1968, 1972, 1976A, 1976B), are

bilingual and bidialectal children (who must deal with more than one language system) more likely than monolinguals to have problems in selectively attending to highly informative areas in the sentence? We do not know. Furthermore, we do not know if there is significant variability *within* these groups due to individual differences in perceptual strategies.

If research into reader's perceptual strategies were to show that better readers attend to different parts of the paragraph or sentence than do poorer readers, then further research would be indicated to determine if the performance of poorer readers would improve by teaching poorer readers to look for the same kinds of information that good readers attend to. It is important to point out that the training indicated here for the reader would deal with his, *cognitive* skills, *not* with his *oculomotor* skills. If research into readers' perceptual strategies were to show that there are significant group or individual differences in perceptual strategies, further research would be indicated to determine if teaching to the student's preferred perceptual strategies would improve his reading, or if adding to the reader's repertory of perceptual strategies would increase his level of comprehension and his speed of comprehension.

Individual Differences in Perceptual Strategies

Some years ago, in his review of eye-movement research in reading, which encompassed 72 studies, Tinker's (1958) *total* discussion of individual differences is as follows: "*Individual differences.* Wide individual differences are always found in reading. These are readily detected in eye-movement records. Special emphasis is placed upon these variations by such authors as Morse (1951), Dixon (1951), Ballantine (1951), and Gilbert (1953)." Thus over an 11 year period, Tinker identified 72 studies dealing with eye movements in reading, and only four of these studies--about six percent--emphasized individual differences.

"[T]he necessity for studying individual differences in the perceptual span" has been identified as a research priority (Raynor and McConkie, 1974). Also, it has been noted that "visual processes are more active and intentional than was long believed (Geyer and Kolers, 1974)." Yet, the question of possible group and individual differences in the perceptual strategies that readers use to extract meaning from written language has not been investigated, even though (a) linguists have developed procedures for analyzing the linguistic structures that readers have to comprehend in the course of extracting meaning from written language, (b) psychologists have developed tools and procedures for studying readers' perceptual strategies, and (c) educators have identified populations of learners who are of major concern.

"[A] crucial role in problem-solving is played by man's short-term memory and the processes that transfer information from short-term to long-term memory (Simon, 1974)." Operating within short-term memory are control processes--cognitive strategies such as selection of information and rehearsal of information under the *voluntary* control of the perceiver (Atkinson and Shiffrin, 1971). Consequently, educational intervention strategies can be formulated to improve these control processes and the ways the perceiver deploys them to extract meaning from written language.

"With increasing age, the child's perceptions are more and more dominated by organized search patterns that are related to sustained 'plans' or ongoing behavior patterns of the perceiver (Maccoby, 1969)." Coffing (1971), Cooper (1974), Loftus (1972, 1976), Mackworth and Bruner (1970), Norton and Start (1971), and Simon and Barenfeld (1969) have shown that the perceiver's eye movements reflect his internalized cognitive structures, maps, and strategies for processing pictorial information. Young children tended to see similarities and to ignore small differences in detail when they were asked to decide whether two complex pictures were exactly alike or different (Vurpillot, 1968). The same phenomenon has been found when children were asked to judge whether two words were identical or different (Nodine and Lang, 1971). However, as children mature, their eye

movements reflect more appropriate and efficient ways of coping with the task at hand.

A Neglected Area of Research

Study of differences in perceptual strategies students employ in comprehending written language is a neglected area of research. The Corder (1971) analysis of research on methods of teaching reading concludes that: "Most of the research on method, for example, has been based on the assumption that method alone makes a major difference in learning to read and has ignored or left uncontrolled other significant variables such as learner and teacher characteristics." Grimes and Allinsmith (1961) found that "individual differences in such factors as selective perception or emotional needs may dispose pupils to find that one or another method of teaching makes learning easier, more palatable, or more satisfying. The classroom procedure that is effective for some children may prove to be deleterious to the performance or development of others."

The reviews of the reading research literature emphasizing models, theories, and descriptions of the reading process and of learning to read contained in Davis (1971) identified over 100 such "models" (Kling, 1971). Yet, these models, almost without exception, attempt to analyze reading in terms of some "idealized reader"--an "idealized information processing system." This approach totally ignores possible differences in students' background experiences (e.g., language background), their purposes in reading, and their cognitive styles--including their learning styles, problem-solving strategies, and strategies for selectively attending to different dimensions of the task at hand.

Recently, the failure of reading research to investigate possible group and individual differences in perceptual strategies has come under attack. Geyer and Kolers (1974) point to "the flexibility of the human being as an information processor." Cognitive psychologists have been criticized (Neisser, 1974B) for limiting their definition to the perceiver to just that of "an information-processing system." Neisser (1974B) points out that the perceiver is an agent and not "an idealized system." He maintains that cognitive psychologists should not limit themselves to what the perceiver knows. Rather, they must also take into account who the individual perceiver is, what he wants to do, and what his strategies are in approaching the task. "It may be more fruitful to strive for ecological validity than for theoretical inclusiveness and to study natural rather than an increasingly artificial intelligence (Neisser, 1974A)."

Research into the reading of bilinguals, such as that of Kolers and Macnamara has dealt with adults who are accomplished readers and fully fluent speakers and readers of both languages involved in the studies. The Kolers and Macnamara research analyses of bilinguals' reading is thought-provoking and should stimulate further inquiry, but it does not deal with the bilingual children in U.S. schools who are experiencing difficulty with reading and who are not fully fluent in both languages. Also, as has been mentioned, the Kolers and Macnamara research dealt with adults. The research of Lambert and his colleagues in Quebec deals with bilingual children from economic stratum different from that of the bilingual children who are experiencing difficulty with reading in the U.S. Also, the Lambert studies do not consider the perceptual strategies used by the children to extract meaning from written language--they only consider overall reading achievement as measured by commercial paper-and-pencil reading tests.

An evaluation of a set of papers developed by basic researchers in psychology and linguistics interested in reading points out that "none of the papers delivered here [presented in Kavanagh and Mattingly, 1972] has attempted to consider the possible effect of dialectal variations on the relation between speaking and learning to read, or to assemble and evaluate the facts relevant to this aspect of the problem (Miller, 1972)." Also, it has been estimated that some 95 percent of visual research has been done with adults (Haber, 1972). Thus, researchers

concerned with the basic linguistic, cognitive, and perceptual processes underlying reading have not focused their analytical procedures and tools on the groups that are having difficulties with reading. On the other hand, the applied researchers directly concerned with the reading problems of economically disadvantaged minority group students have not used the kinds of analytical procedures and tools that the basic researchers have available. However, if line-of-sight (eye fixation patterning) measures of information processing in reading were used, objective data would be available: Either the reader fixated a particular area of the text or he did not. Either a regression was made at a particular point or it was not. Also, the number of fixations (or regressions) can be objectively and accurately counted, and the duration of each fixation can be objectively and accurately measured. Research into readers' perceptual strategies should apply the research procedures and tools of basic researchers to the student populations of most concern to educational researchers and clinicians.

Briefly stated, a research program needs to be developed to investigate the strategies that readers use to "perceptually attack"--to use N. Mackworth's term--sentences, paragraphs, and larger units of text in order to extract meaning from them. This is the logical extension of the research knowledge we have about the reader's *word*-attack skills. A large amount of research and instructional materials development has been done on children's word attack skills. Most beginning reading programs emphasize either phonics or the whole-word approach, and both of these approaches use the word as the largest unit. However, it has been stated that there are many children who can decode words, but who are unable to comprehend the meaning of the sentences and texts in which those words occur (Samuels, 1973).

Readers' perceptual strategies can be studied by monitoring their eye-fixation patterning as they read. What readers do and do not look at, and what causes them cognitive difficulties--as indicated by more eye fixations, or longer fixations, or more regressions--in relation to what they comprehend, can provide information about the relative effectiveness of different perceptual strategies.

CONCLUSION

In conclusion, it has been pointed out that extant models, theories, and descriptions of reading and of learning to read attempt to analyze reading in terms of some "idealized reader"--an "idealized information-processing system." This approach ignores possible differences in students' background experiences (e.g., language background), their purposes in reading, and their cognitive styles--including their learning styles, problem-solving strategies, and strategies for selectively attending to different dimensions of the task. It was also pointed out in the preceding section that researchers do not know if (or how) the perceptual strategies (the sentence-attack, paragraph-attack, etc, skills) of high-achieving readers differ from those of low-achieving readers. Also, researchers know little about how the perceptual strategies of different readers relate to their language background, or to their reading comprehension. And researchers know little about how the perceptual strategies of different readers relate to the semantic/syntactic characteristics of the materials these readers encounter. Since selective attention plays an important role in the extraction of meaning from written language, the preceding discussion argues for the use of eye-fixation patterning studies to analyze the types of perceptual units that readers use. This second research strategy is concerned with the development of "perceptual-attack" skills in relation to the development of reading comprehension skills. This second research strategy parallels Research Strategy 1, since both are concerned with the development of perceptual units. The work of Söderbergh, Brown, and other developmental psycholinguists provides useful models for those of us trying to increase our understanding of how reading skills develop.

Communication and Cognitive Style: A Clinical Perspective

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The traditional activities of the clinical psychologist--psychological assessment and psychotherapy--rely heavily upon language. In assessment, the adequacy of performance on many types of "intelligence" tests is indexed by verbal behavior. On so-called "projective" tests such as the Thematic Apperception Test and Rorschach's test, the child or adult verbally conveys his perceptions, interpretations, and associations while the clinician proceeds to make inferences about personal concerns, defenses, and cognitive operations from these messages. In many traditional forms of psychotherapy, such as the psychoanalytic and client-centered modes, it is claimed that the patterned exchange of communications is the vehicle for behavior change. In this paper, some applications of psycholinguistics to clinical practice will be summarized, and some issues that clinical practice raises for psycholinguistic research will be indicated.

COMMUNICATION AND MEANING

Communication can be defined as the process of one person getting his *meaning* across to another person. For the moment, we shall consider communication in a clinical situation (and perhaps in many other social situations as well) to involve three sets of factors: (a) linguistic, (b) paralinguistic, and (c) extrinsic.

Linguistic factors are the types of variables examined in relation to verbal behavior, shorn of extra-language features. One major set of linguistic factors involve form: The surface structure of an utterance, its underlying deep or conceptual structure, and the rules used in relating the two. In clinical practice, one seldom attends systematically or quantitatively to these aspects of language; yet the clinician often makes evaluations of, and responds to, structurally diverse utterances in equally diverse ways. For example, a client who speaks in complex sentences with many subordinate clauses and qualifiers may be considered an "obsessive," and a particular type of therapeutic intervention would be aimed at this quality.

A second major set of linguistic factors involve *content*. This encompasses more than just the specific language (e.g., English) used by the client or even the sophistication of his lexicon (although a client using very esoteric jargon may be viewed and treated as an "intellectualizer"). It refers also to the classes of events that the client verbally reports--the topics that he discusses. Many researchers have developed elaborate systems for coding the presence and frequency of occurrence of different types of content variables, and by far the greatest amount of work has involved this sort of approach rather than a focus on the structural properties of language.

Paralinguistic variables are those which supplement, modify, or enrich an utterance in such a way as to affect its meaning. In psychotherapy, as well as in clinical assessment, the clinician attends to kinesics (movement, posture, facial expressions), tone of voice, loudness, pauses, etc., as well as to the verbalization per se in attempting to understand the meaning of his client's communication. For example, in discussing an unpleasant incident where he is reprimanded by a superior at work, a client may admit that he "was angry" and convey this by loudness, gesture, and facial expression as well as language content. On his side, the clinician monitors these paralinguistic features in his own verbal interventions. Psychoanalytic work prescribes a certain detached

interest in and concern for the client; the therapist therefore attempts to regulate the expression of strong emotion and inhibit pronounced gestures when he speaks. In client-centered work, the therapist tries to convey, paralinguistically as well as through language content, an attitude of unconditional acceptance and warmth.

Extrinsic factors are those which may impinge upon the process of communication but which remain somewhat apart from it. They include the immediate social situation and the sets or expectations that the client brings to it. These may affect both linguistic and paralinguistic aspects of communication. For example, a hospitalized psychiatric patient seen for an interview or testing which he believes may influence a decision on his release frequently attempts to impress the clinician with the sociability and rationality of his behavior and utterances. Alternatively, a college student at an intake interview in an overworked university counseling center may feel he has to present himself in as troubled and negative a fashion as possible to convince the agency that he needs help; his utterances may become longer and more complex. A client of lower socio-economic status may feel he has to use big, technical words rather than colloquialisms in talking to professionals. A psychoanalytic patient is instructed to say whatever comes to mind; his utterances may be simple in structure with little logical relationship.

Disregarding these extrinsic factors, however, the relative significance of linguistic versus paralinguistic features in therapeutic communication has been a topic of some debate. Is language content per se a sufficient indicator of the events of psychotherapy, or must paralinguistic aspects of communication be considered as well? Gottschalk, Winget, Gleser, and Springer (1966) state that "the relative magnitude of an affect can be validly estimated from the typescript [of] speech...using solely content variables and not including any paralinguistic variables....The major part of the variance in the immediate affective state of an individual can be accounted for by variations in the content of the verbal communication." Gottschalk et al suggest that paralinguistic phenomena only amplify upon, or provide an additional and usually redundant source of information about, verbal content variables. They also note that paralinguistic variables have little research utility since "no one has yet been able to devise a reliable method to measure affects using these variables."

Other researchers, however, do not feel that attention solely to language content is sufficient for describing communication in clinical situations. Haggard and Isaacs (1966) found that when patients seemed to be in conflict about an issue, their fleeting facial expressions would display a different emotion from the content of their utterances. They state "the patient may [facially] show a micromomentary burst of anger while talking about liking someone." The expressive gesture, in their view, serves to modify the meaning of the communication.

In a similar vein, Deutsch (1966) has attempted to correlate verbal and kinesic aspects of communication through the use of sound films of psychotherapy. He feels that "unconscious emotional needs which cannot be discharged in words lead to...postural behavior." Deutsch has presented some raw data on one patient together with his comments upon it in an intriguing article. He describes how, at one point, the patient verbalizes that he "had to go to somebody for help" and simultaneously stretches his hand outward. According to Deutsch, "the stretched out hand expresses the plea for help." In this instance, verbal and kinesic aspects of the communication coincide; but the process of analysis can become far more complex and inferential.

Thus, the question "Is language content a sufficient indicator of the events of psychotherapy?" has never satisfactorily been resolved. Some investigators have been extremely pessimistic about the relevance of purely linguistic techniques in examining clinical communication. Dittman and Wynne (1966), for instance, conclude in their study of linguistic and paralinguistic phenomena in psychotherapy that *emotional* aspects of speech are very different from *linguistic*

aspects and that "methods developed in traditional linguistic analysis may not be applicable to the analysis of emotional expression." If this view is accepted, then attempts to study clinical interaction through linguistic variables will bear little fruit. Yet, this may be a too hasty and overly broad rejection of linguistics. Part of the problem involves two senses of the term *meaning* in clinical communication.

Conceptual Meaning

This sense of clinical meaning corresponds to deep or conceptual structures. It involves some underlying kernel notion(s) which has been actuated through an utterance with one or another surface structure. At one level, the clinician tries to understand the content of the message sent by the client. Here, the clinician's task does not differ substantially from that of anyone trying to conduct a rational conversation. However, the most crucial kinds of communication that clinicians have to decode are those which have an ambiguous deep structure--those which admit two or more conceptual underpinnings as possible meanings. A clinical example of this type of utterance might be "I feel hot." Many psychoanalytically oriented clinicians would hold that no research, other than intensive case studies, could be done on utterances of this type since their deep structural meanings would vary from client to client.

Even given this potential limitation, it would be interesting to explore under what conditions and with what sorts of clients ambiguous utterances occur. One hypothesis might be that clients emit them in earlier stages of psychotherapy, when they as yet have little insight regarding the nature and sources of their problems and feelings and possibly less experience in differentiating among feeling states. Another hypothesis might be that ambiguous utterances tend to occur at any point in treatment when the client begins to grapple with new, hitherto unexplored issues. It might also be that clients with particular types of defenses or dynamic patterns tend to use ambiguous utterances, e.g., obsessives who are prone to grave doubt.

One major area where linguistics and clinical communication seem naturally to dovetail is in the interaction patterns of the families of schizophrenics. A well known approach to these patterns has been the "double bind" concept of Bateson, Jackson, Haley, and Weakland (1956), further elaborated by Weakland (1960). The "double bind" refers in part to an interpersonal situation where one or more persons (usually family members) aim two mutually exclusive orders of a message at a target person (the schizophrenic), either through an utterance with conflicting meaning, or through one utterance with an ambiguous deep structure. (Other requirements of the situation are that the receiver cannot comment on the ambiguity or leave the field and that the receiver's relationship to the sender(s) is a "vitally important" one.)

Most of the "double bind" hypotheses have been inferred from clinical observation and little quantitative research has been performed. Two researchable questions would appear to be: Do family members aim messages at the schizophrenic which have conflicting linguistic and paralinguistic meanings? If so, in what situations and with what frequency?

Another research issue from the point of view of linguistics concerns the translation of conceptual meaning into surface structure. It might be that under certain kinds of conditions, different types of clients would tend to express the same deep structure meanings through different surface structures. For example, under conditions of anxiety arousal, an obsessive client might resort to complex, hierarchically organized sentences in the passive voice while a hysterical client's utterances might become simpler and shorter--although both might be attempting to express the same underlying meaning.

Also, it might well be that patients' reactions in psychotherapy vary not just according to the type and degree of content communicated to them but also

according to the form of the communication itself. Then, one might expect certain types of patients to be more responsive to the same underlying conceptual structure according to how it is realized in the surface structure of the therapist's speech. This is a very real problem in the practice of psychotherapy: How does one phrase a message to have maximal impact upon the client? A psycholinguistic approach to this problem would have merit.

Symbolic Meaning

Psychoanalytically oriented elinicians hold that there is another type of meaning in verbalizations that goes beyond conceptual meaning. In symbolic meaning, certain items in the patient's lexicon have additional personal meanings, such meanings are idiosyncratic and go beyond those which can be readily shared in the language of the patient's subculture. They are unique and not found in dictionaries. The most famous examples of utterances with presumably symbolic meaning are verbal reports of dreams such as Freud collected in his many case studies. Verbalized elements of dreams, according to Freud, stood for other meanings through some mechanism of associative similarity--similarity in appearance, function, physical location, etc. It is important to note that normally one can easily describe a verbal account of a dream in linguistic terms of surface and deep structure. Impossible dream events can be linguistically described in a very complete way, e.g., "I dreamt about a monster riding a mushroom with wheels." Yet a psychoanalytically oriented clinician would go beyond even the ambiguous deep structure of this communication ("The monster has wheels and is riding around on the mushroom" or "The monster is riding on a wheeled mushroom.") to some presumed symbolic meaning. Another extreme instance of symbolic meaning occurs in the private languages sometimes developed by psychotic individuals. As with the dream, while the structure of the personal language could be adequately described in linguistic terms, the symbolic meaning might not.

It seems likely, then, that some varieties of linguistic research would have little to offer for clinical research on symbolic meaning. Even if one were to establish reliable and somehow "valid" symbolic meanings for a person's communication in a clinical situation, apart from the outright claims of psychoanalytic therapists, the linguistic task would merely consit of compiling a lexicon of personal meanings for each patient, a tedious research enterprise with probably limited generalizability. Linguistic research on conceptual meaning and forms of communication, as indicated above, would probably yield vastly more profit.

ASSESSMENT AND INDIVIDUAL STYLES

Psychological assessment is the description and evaluation of individuals and, as indicated earlier, in large measure traditionally involves verbal behavior. On most widely used intelligence tests, the child or adult responds verbally to over one-half of the items and most of the time must comprehend verbal instructions. Responses to Thematic-Apperception Test cards, sentence completion blanks, the Minnesota Multiphasic Personality Inventory, and Rorschach inkblots heavily involve language.

In ego psychological assessment, the diagnostician goes beyond the compilation of test scores and aims at portraying the internal structure of a person's cognitive operations and motives and assumes that how they combine is unique for each person. Furthermore, although one tries to suppress it at times, there tends to be more of an emphasis on deviation, usually in the sense of "deficit" or "abnormality." Modal cognitive or personality characteristics often receive little comment or are treated as if they hold little interest or importance.

In contrast, psycholinguistic research tends more typically to be concerned with commonalities among all individuals at a certain age than with uniqueness. For example, recent summaries of language acquisition (Brown, 1973; McNeill, 1970;

Menyuk, 1971) discuss at length the universals in the developmental sequence of language structures with relatively less attention paid to accounting for uniqueness.

Both clinical assessment and psycholinguistic research seem to come together, however, in studies of special subgroups of individuals. For example, Menyuk (1971) cited her own 1964 study of children diagnosed as using "infantile speech" where physiological causes had been ruled out. She noted that children using so called infantile speech produced structures not identical with normal speech in earlier developmental periods: "They had developed a grammar that was more sophisticated in terms of some structures and different in terms of others." Furthermore, she found that "normal speaking children have the capacity to store fully or at least partially analyze a sentence...children using disordered language are incapable of this task unless the utterance is short enough and/or simple enough."

From the clinical viewpoint, many language studies have been performed with different diagnostic groups or syndromes. Vetter (1969) has summarized a large amount of this literature. Some of the language characteristics of schizophrenics (apart from content) that Vetter mentions are the following: "(1) the schizophrenic is less precise in his understanding of...meaning...(2) [He] is less able to use his words as conceptual instruments...(3) [His] ability to integrate words into meaningful communications appears impaired, though he may 'define' the same words in the same way that the control subject does." Thus, one integration of clinical and linguistic viewpoints has been through the description of language behavior of contrasting diagnostic categories or groups. A related approach to assessment has been the psychoanalytic empirical research on *cognitive controls and styles*. The implications involve both language structure and language acquisition.

Cognitive Style

Psychologists and educators who are "score-oriented" tend to think of psychological tests primarily in terms of content. That is, a test indexes a certain percentile or level of "intelligence" or a certain quantity of knowledge. In contrast, "ego psychological assessment" is concerned with the thought processes that a person displays in responding to tests; that is, the manner in which the person arrives at a correct (or incorrect) answer to, say, an intelligence test item becomes as important as the fact that the answer is right or wrong. A Wechsler Intelligence Scale for Children Comprehension subtest item is "Why should we keep away from bad company?" Two possible answers might be (a) "Because they get you into trouble." or (b) "Well, I'm not sure. People don't, usually at least, agree on what 'bad company' is; therefore it depends on the meaning for a particular person. I guess most people, who are conformists, might say so called 'bad company' might influence or coerce an individual into unlawful, possibly immoral, acts." Both answers would receive full credit in the WISC scoring Manual; however answer (a) is direct, almost automatic and association-like, and efficient, while answer (b) displays greater awareness of alternatives as well as qualification and, in a real sense, relative inefficiency of verbally producing a "correct" answer. In ego psychological assessment, item-by-item analysis of the test performance, including language, and overall patterns of subtest scores, give the clinician a picture of the strengths, weaknesses, and the stylistic qualities of ego functions such as memory, evaluation, concept formation, attention and concentration, anticipation and planning, and delay and control of action and speech.

Cognitive controls are broad strategies of perceptual and cognitive adaptation. The specific controls which have been explored include (a) constriction-flexibility (the capacity to ignore irrelevant cues); (b) leveling-sharpening (the degree to which successive experiences blend into each other or remain discrete); (c) tolerance for unrealistic experiences (i.e. experiences contrary to knowledge of the actual situation); (d) scanning (the extent to which attention is systematically

deployed to many aspects of a situation); (e) equivalence range (the breadth and number of categories used in classification); and (f) field articulation (essentially identical to Witkin's [1965] field dependence/independence dimension). *Cognitive styles* are thought to represent relatively unique combinations of specific controls. Cognitive controls have been related to more specific intellectual abilities (Gardner, Jackson, and Messick, 1960) and studied longitudinally (Gardner and Moriarity, 1968).

One conceptual framework for both cognitive controls and language behavior is the psychoanalytic theory of thinking (Rapaport, 1967A, 1967B, 1967C). Since there is inevitably some delay in satisfying the infant's drives, the theory holds that the infant resorts to "hallucinating" to obtain an illusory, but partially gratifying, experience. It is as if the infant "fools himself" that his tensions have been reduced. One need not think of "hallucinatory" experience as necessarily visual or clear, but as a vague sense of well being. Gradually, through maturation and experience, the infant begins to develop notions of how means-end relationships actually work in reality (spatial, temporal, correlational, etc.) (Rapaport, 1967A).

Rapaport (1967B) suggests that there are aspects of the capacity to acquire and use language which all individuals (at least within a subculture) share, yet, clinical observation as well as cognitive control research suggest that individuals with presumably different styles tend to process and use language in characteristically different ways. If he is accurate in his assertion that almost all individuals attain the capacity in adulthood to produce most of the basic forms in the subculture's language, then differences in characteristic verbal expression may in part result from, or at least be associated with, differences in cognitive styles. That is, certain cognitive controls or stylistic patterns may be associated with an individual's tendency to employ certain types of rules and, consequently, certain types of surface structures. Exploring these processes and relationships in detail then, would seem to be an important psycholinguistic task which would have clear clinical relevance.

There have, however, been some research attempts to relate cognitive controls specifically to reading processes if not to other aspects of language. Santostefano, Rutledge, and Randall (1965) studied scanning, contstriction/flexibility, and leveling/sharpening in groups of eight- to twelve-year-olds with either a current reading disability (average of 1.5 years behind on the Botel Reading Inventory) or no disability. While no differences were found between groups for two of the cognitive controls, poor readers tended to be significantly more toward the constricted end of the constriction-flexibility continuum. The authors concluded that "one cognitive mechanism crucial for reading is concerned with processing information in the context of distractions and with an individual's ability to withhold attention selectively from irrelevant and intrusive information" (see also Gibson and Levin, 1975; Ross, 1975). Poor readers lacked this capacity for flexibility.

Investigating the relationship of field dependence/independence to reading comprehension (on the Sangren-Woody Reading Test), Cohn (1968) found that field independence in sixth graders correlated significantly with four (out of eight) apsects of comprehension, those aspects which Cohn interpreted as involving the ability to articulate and actively restructure material. Other aspects of comprehension, which Cohn felt heavily involved experience or reliance on authority, failed to correlate with field independence.

Some other variables of individual style, besides these psychoanalytically based cognitive controls, have been investigated in relation to reading. For example, Kagan (1971) has explored the role of evaluation in problem solving along a dimension of "reflection-impulsivity"--"the degree to which the subject reflects on the validity of his solution hypotheses in problems that contain response uncertainty." Reflective children presumably fear making errors more than do impulsive children who have little anxiety over giving a quick answer, regardless of its accuracy. Kagan (1965) has related this dimension to reading

ability. He asked first graders to choose one of five printed words that matched a word the experimenter was speaking. Reflective children took more time, as well as made fewer errors, in comparison with impulsive children and this was a factor even with "verbal ability" controlled (Kagan, 1971). A year later, the same reflective children made fewer errors than the impulsive children in reading aloud. Kagan notes that many of the impulsive children's errors were characterized by misreading of closely similar words, such as *truck* for *trunk*.

Another aspect of individual style which has been explored is that of categorization preferences (Kagan, Moss, and Sigel, 1963). For example, children using "analytic" concepts tend to categorize a collection of elements on the basis of a subpart that the elements have in common. In relation to reading, Serafica and Sigel (1970) found that boys with reading disabilities tended not to use an "analytic" approach to reading.

A more recent and elaborate study (Davey, 1971) has examined the relationship of an "analytic" or "nonanalytic" style to reading errors in achieving and underachieving readers. Davey took groups of achieving and underachieving fourth grade boys and cross-classified them into "analytic" and "nonanalytic" subgroups on the basis of the Sigel Conceptual Styles test. All subjects were then given an oral reading inventory and errors counted and coded. Among achievers, reading errors that were made produced little change in the meaning of sentences; however analytic achievers were less likely to make punctuation errors than nonanalytic achievers, perhaps suggesting that they do focus on small details and subparts of a sentence. Among underachievers, errors that were made tended to result in change of meaning. But it was found that analytic underachievers depended unsuccessfully on small graphic cues (perhaps giving these fragments of information too much weight and thus "missing the point"). Nonanalytic underachievers tended to overuse contextual cues, and misunderstood in this fashion.

Kagan has suggested that "analytic concepts increase with age in part because older children often pause and reflect longer (Mussen, Conger, and Kagan, 1969)," as well as because of categorization preference. There may be some complicated interrelationship of analytic and reflective styles such that their co-occurrence facilitates the acquisition of reading skills at a stage where reading heavily relies upon perceptual discrimination. In relation to this type of approach, Athey (1970, 1976) has concluded that the parameter of cognitive style might prove to be among the more important variables of the working system for reading.

SUMMARY AND CONCLUSIONS

Language behavior has special relevance for the work of the psychotherapist and psychodiagnostician. This paper has attempted to explore relationships between research on language, and clinical practice and research, in two major areas: (a) problems of communication and meaning (particularly in psychotherapy) and (b) issues in the assessment of individual styles. In both areas, relevant literature was reviewed and suggestions for further research were made. With regard to communication and meaning, it was concluded that a psycholinguistic approach would have an important contribution to make to the events of psychotherapy concerned with the conceptual meaning of verbalizations, but less relevance to problems of symbolic meaning. With regard to assessment, it was indicated that cognitive style would be an important concept common both to the work of clinical evaluation and to the study of language behavior.

The Role of Intention in Reading and Thinking

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Humans possess a natural propensity to inquire, and early in life the role of intentional action and the consequences of that action begin to shape a person's intellective structures. Students can and should be taught to perform as critical and creative persons "...possessing a solid cognitive bedrock, something flexible and plastic and yet consistent and enduring...(Flavell, 1963)." If it is accepted that critical, creative, and versatile reading is a process akin to thinking, then instruction that will best achieve such goals is needed. The implications and relevance for education in general and reading instruction in particular, are considerable.

Effective instruction must require students to pin down their own problems and raise their own questions, to locate materials, to find answers, and to weigh evidence and determine its value. So, as children mature they will achieve a clearer grasp of reading dynamics, and be versatile, critical, and creative thinkers. All this is accentuated by the fact that as Sigel and Hooper (1968) say, "people display...special manifestations of a general human need to construct invariants from diverse psychological inputs."

PUPIL AND TEACHER QUESTIONS

It is significant to note that a basic element in strategies for learning is intention. Similarly it is the purpose of a reader that determines not only his rate of reading but also the nature and depth of his achievement.

The reading-thinking process must begin in the reader's mind. He must raise the questions or if he accepts questions someone else raises, then he must make the questions his own by speculating about likely answers. The responsibility and the tyranny of "a right answer" belongs to the reader.

Strategies of thinking must be learned and therefore must be taught. This is done in what Piaget (Duckworth, 1964) calls *provoked* learning situations--situations imposed by a teacher (or someone) with respect to some didactic point and limited to a single problem or a single structure. The acquisition of strategies for effective reading-thinking depends very much on the teacher and the teaching techniques used. The teacher must be dedicated to the proposition that reading is an intellectual process requiring the ability to make decisions and deal with alternatives. What is done to promote critical reading, regardless of level, is what makes the difference. Said differently, children can be trained to be thinking readers at any level.

Ennis (1962A, 1962B) has said that critical reading is the use of critical thinking in the act of reading. Russell (1961) maintained a similar position and defined critical thinking as a three-factor ability. He included an attitudinal factor of questioning and suspending judgment, a functional factor of logical inquiry and problem solving, and a judgmental factor in terms of some norm or consensus.

A significant study by Taba, Levine, and Elzey (1964) was concerned with teaching strategies and thought processes. Her multidimensional analysis of classroom transactions in terms of measurable changes in levels of thinking had several advantages. Results showed that children can learn to make inferences, to generalize, and to make logical assumptions if they receive systematic instruction. The enormous influence of teacher behavior on the thinking of students was most impressive.

A comprehensive study done at Ohio State University (Wolfe, Huck, and King, 1967) attempted to determine whether or not children in the elementary grades could be taught to read critically. Bloom's (1956) approach to ways of ordering knowledge influenced the development of a classification system for teachers' verbal behavior, and Guilford's (1965) structure of the intellect proved useful in determining the separate types of pupils' thinking. Results indicated that teaching critical reading is feasible to children of both sexes, and that achievement is influenced by intelligence, general reading ability, and personality. Also that teaching skill--especially the ability to ask questions and interpret pupil responses--was a key factor (Wolfe, Huck, and King, 1967). In this latter respect it is interesting to note that Gallagher (1964) showed how the questions a teacher asked determined the kind of thinking the student did.

Suchman (1960, 1961) has been experimenting with the teaching of strategies and tactics of scientific inquiry to children and has devised a method known as inquiry training. He states that inquiry is "the pursuit of meaning" and his major emphasis appears to be on the means by which knowledge is acquired. The function of "directed thinking" may be defined as "to convey to us the solution of problems." In so doing directed thinking involves both epistemic behavior and symbolic behavior. Such thinking is launched by a "felt difficulty," a problem, a question, a conflict, uncertainty or disequilibrium and is, in turn, motivated thereby. The native propensity of the mind to ask "why" from age three on and its compelling force are still far from understood psychologically or physiologically, but there seems to be little doubt about the potency of the desire for equilibrium in the function of learning and thinking and their responsibility for adaptive change.

REGARD FOR THE ROLE OF INQUIRY

Jacques Monod (1971), Nobel prize winner and director of the Pasteur Institute in Paris, in his profound book *Chance and Necessity* advanced the basic premise of the scientific method by saying that nature is *objective* while man as an intelligent human being is *projective*. Thus by reference to man's own activity--conscious and projective, intentional and purposive--the artifacts he makes are products of a conscious purposefulness as opposed to the products of nature which are neither planned nor purposive. Every artifact (word or thing) is a man-made product endowed with a purpose or project resulting from the application of forces exterior to the object itself. A hammer or the word *hammer* is man-made and attests to a conscious and rational intention. The object hammer or the word *hammer* as either an artifact or a construct for an artifact, has about it the structure and connectivity of knowledge and can, so to speak, cause one to spin ahead of hammer to predict how it will or might be used. These are ways one may predict, interpolate, and extrapolate. Without such artifacts, knowledge would not be what it is.

Implicit in all this is the concept of *intention*, with self-imposed direction. Action and purpose represent the core idea and impose a selectivity, a biasing effect on our knowing and on our uses of knowledge. Intention in thinking, like purpose in reading, is crucial to comprehension or functional understanding. Thus it is timely to do as Bruner and Piaget have done--to turn back to when the child first learns the rudiments of achieving his intentions and reaching his goals. "Enroute he acquires and stores information relevant to his purposes. In time there is a puzzling process by which such purposefully organized knowledge is converted into a more generalized form so that it can be used for many ends. It then becomes 'knowledge' in the most general sense--transcending functional fixedness and egocentric limitations (Bruner, 1971)."

In brief, the tools provided by a culture as well as man's insatiable urge to see cause and effect, to note means-ends relationships, are predicated on intention and direction. The object hammer expresses purpose which it exhibits

in its structure, and man's urge to use it can provide many creative examples of functional adaptation--to beat, to throw, to prop up, to decorate. Similarly, the word hammer has both semantic and syntactic variability that the richness of language can represent--*the hammer, to hammer, hammer down, hammer home.*

Edmund Burke Huey said that when reading was done for the attainment of the reader's purposes, it became excellent practice in the higher thought processes. The feeling for values and the choosing of the relevant requires, he said, a mental discipline that is "...golden practice in the training of judgment (Huey, 1908)." He went on to say that "real reading" whereby the reader actively and sympathetically follows the ins and outs of an author's intentions, his fidelity to truth, his accuracy and method, "...cannot but train the mind to modes of functioning that are similar to his (Huey, 1908)."

If it is accepted that reading is a process, a way of thinking, then the interpretations provided by Arthur Gates add an astute dimension. "Reading is... essentially a thoughtful process...a complex organization of patterns of higher mental processes...and should embrace all types of thinking (Gates, 1949)." If one adds the perspectives of the semanticists, we note that to read one must not only be concerned with scientific objectivity (systematic observation, tested assumptions, evaluated experiences) but also with the adjustment or emotional balance of people. For as C.K. Ogden and I.A. Richards (1946) say, "...understanding the process of interpretation is the beginning of wisdom."

In brief, then, it appears that reading is a mental process akin to thinking. Or to state it differently, critical reading is akin to reflective or productive thinking. One must also allow for the fact that reading can be done for vague, unclear affective reasons and/or for unregulated thinking. Thus, reading can be done at various degrees of sophistication both for entertainment and learning. Likewise, thinking can be either regulated or largely unregulated. When reading to learn is required, the reading-thinking process must be productive. When reading for entertainment, the reading-thinking process can be largely unregulated, varying with the amount of involvement desired.

I have defined critical reading as a means of judgments based on values and a choice of the relevant. To make decisions and deal with alternatives requires mental discipline. In essence the dimensions of critical, creative, and versatile reading are: Ability to actualize concepts and intentions; ability to sift information and determine its relevancy to one's anticipations as well as to actively follow an author's intentions and fidelity; ability to deal with constraints and invariants in terms of goals being sought; ability to maintain in dynamic equilibrium the personal components of convictions and inclinations; ability to accept responsibilities involving choice and volition among different options and exercised on the basis of consequences; and ability to internalize the knowledge gained and use it in other situations.

Psychologists similarly place a high premium on the role of "intention" in thinking. Vinacke (1952) says that thinking as behavior always occurs in response to some stimulus. If no particular response is required the thinking may be more imagination than reason, but if a particular response is possible and is required, the thinking requires more reasoning than imagination. Hence the selective factors that channel thinking are crucial.

Wertheimer (1959) said that to get to the core of the problem, the magic key, thinking, is concerned with ends and "...in real thinking the functional meaning of an item...that meaning which changes as thinking advances is of utmost importance." Thus productive thinking is conceived to be a dynamic, fluid process concerned with ends (Stauffer, 1969).

John Dewey (1933) considered only reflective thinking because it emancipates us from merely impulsive routine activity. Thinking enables us to direct, act, know, to "...act in a deliberate and intentional fashion (Dewey, 1933)." His first step in how we think was a "felt difficulty" or as he said later, "1. suggestions in which the mind leaps forward to a possible solution" and "2. an

intellectualization of the difficulty...into a problem to be solved." David Russell (1956) leaning heavily on Dewey listed as his second step, "the orientation or initial direction of the thinking is established."

It seems a ready conclusion that among varied scholars, the role of *intention* or direction or inquiry is of first order importance in thinking. It permits one to direct his activities with foresight and plan according to ends in mind or objectives of which one is aware.

MANIFESTATIONS OF INTENTION AND GOAL SEEKING

Observations of infants in the sensori-motor phase of life provide information about how children first acquire ability to achieve intentions and reach goals and/or use knowledge as a guide to purposeful action. A month-old baby (Bruner, 1971) may stop sucking the nipple of a bottle when a moving object catches his eye and produces ocular convergence. Later, a first form of behavioral integration occurs as a new principle between sucking and looking develops and *suppression* is replaced by a system regulated by orderly *succession*. At four months of age an infant is likely to develop a "place-holding" activity as he mouths a nipple rhythmically but does not suck while watching a lively visual stimulus. Thus the rudiments of dealing with a range of options and part-whole relationships is being pieced together. In brief, this suggests that a plan exists "in the mind" of the person acting and influences the sequence of events. Thus, early in life the role of *intentional* action along with the *consequences* of that action begin to shape a person's competence to comprehend or benefit from knowledge and be regulated thereby.

Wallach (1963) in discussing means-ends behavior says "it is no accident that the use of means to secure goals becomes observable at approximately eight-months, for it is around this time that the child becomes adept at categorizing both familiar and new objects in terms of their response-defined uses...prior to this age any associative linkage between a response and some environmental effect is sufficient to lead the child to repeat the response in the apparent expectation of repeating the effect, regardless of consideration of spatial proximity."

By the end of the sensori-motor period a child is able to attain his practical aims, albeit limited to the time and space restrictions of the immediate perceptual present. Object permanency (invariance) or the recognition of "kinship of continuity" in things becomes a general acquisition prior to the use of language but clearly reflecting the role of experience in his problem-solving deeds. Thought rooted in action is directed by the infant toward "...success in his manipulations (from the cognitive point of view) and toward personal satisfaction (from the affective point of view) (Sinclair-DeZwart, 1969)."

In time the child develops models of representation as well as language symbols to express his understanding of coordinated action-schemes. A child pushing a small shell along the edge of a box saying "meow" is using both the shell and the "meow" as signifiers. The former signifies by resemblance and the latter by imitation. Now the stream of action and the stream of language begin to converge and in effect each person develops a theory of language consisting of an infinite number of phonetic-semantic percepts or of sound-meaning correlations. All this the child does without explicit instruction and without being exposed to a uniform "course of experience (Chomsky, 197[illegible])." Linguistic evidence indicates that this generic tendency for language acquisition is an active process. Acquiring the complex web of the syntax of language reflects the categorizing tendency of the human mind. It also reflects the means a culture provides.

Development from approximately the third to the eleventh year (Wallach, 1963) shows conservation of properties across irrelevant changes: amount, weight, volume, horizontality, length, area, number, and duration whereby the underlying cognitive achievements reflect an ability to hypothesize and make decisions. A critical variable overcome during this time is dominance of momentary perceptual

impressions. As the child matures and organizes objects into hierarchies of classes, or sorts them in terms of increasing values of some attribute, performance seems attributable to an increased ability to consider hypothetical possibilities and to their systematic analysis by testing. His thinking begins with an attempt to formulate possible solutions to a problem and then determine which one is correct.

White (1963), in his discussion on probability learning, notes an increasing persistency to find a pattern and order that may result in a winning strategy. He also speaks about individual differences in cognitive styles. "At root, they appear to be differences in impulsiveness, attentiveness, and the ability to focus closely on the environment."

In his insightful paper reviewing Piagetian theories, Kohlberg (1968) explains how the theory is based on the premise that cognitive and affective structures emerge from and are fostered by the interaction between a child and his environment. The implication is that optimal development requires optimal balance between behavior structures and psychological environmental structures. Then he adds that, "from birth, there are inherent motives for cognitive activities, but these motives, too, undergo structural change in development."

In a discussion of the relation of the structure of an experience of a child with a behavior structure Kohlberg (1966) says, "Piaget (1964) has termed such an analysis an 'equilibration' rather than a 'learning analysis'...such analyses focus upon discrepancies between the child's action system or expectancies and the experienced event."

Kohlberg as well as White stresses individual differences in cognitive development and makes a special point of the fact that a child's focus indicates a different structure or organization than the adult's rather than a less complete one. Similarly, Beswick's "Cognitive Theory of Individual Differences in Curiosity," (1971) stresses individual differences. "Individual differences in curiosity are seen to be a function of both category system characteristics and differences in the coding operation. The relevant differences in the coding operation are those which arise when there is some difficulty of coding...the coding will involve a corresponding degree of one or both of two processes of modification: assimilation and accommodation (Beswick, 1971)." A category system represents previous learning with conceptual conflict a necessary part of a coding operation. A curious person is one who develops strategies for dealing with uncertainties which are associated with "an ambivalent expectation of excitement." The higher the curiosity, the greater the tendency toward perceiving the environment so as to increase the probability of coding difficulty. Thus, "the strategy can be viewed as instrumental or purposive." In summary, Beswick says, "the empirical findings are generally in support of a theory of curiosity as a preferred cognitive strategy consisting of an acquired predisposition to increase, prolong, and resolve conceptual conflicts."

Berlyne (1965) holds that curiosity is explained with reference to conflict which is a product of uncertainty and the strength of competing responses. "When directed thinking is used effectively for the relief of conceptual conflict, it seeks information without bias." New material should be presented in such a way that "...it challenges the child's existing beliefs and expectations and makes him sensible of the gaps and inadequacies in his present knowledge structures."

In concept attainment, the formulation and testing of hypotheses are crucial (Bruner, Goodnow, and Austin, 1956; Klausmeier and Harris, 1968; Klausmeier, Harris, and Wiersma, 1964). In the experiments described in the 1968 report, it was evident that past experience of a subject influenced hypothesizing strongly. It was also evident that hypothesizing is done in a systematic, predictable manner in an attempt by the subject to determine a correct cue for responding. As Miller et al said earlier, after a subject receives instructions he develops a vague plan, and then his *intention* to complete the plan keeps him at a task until a correct hypothesis is offered (Miller, Galanter, and Pribram, 1960).

In brief, then, while this literature search is by no means thorough, it does provide insight into early manifestations of intentions and subsequent development. Plans or intentions or strategies seem to exist "in the mind" of persons acting and they are influenced by expectations and associated uncertainties along with the consequences of an action. Gradually, motives undergo changes in development from the sensori-motor period of aim attainment governed by the perceptual present, to the pre-operational and operational stage with thought and intention rooted in reflection and an increased ability to consider hypothetical possibilities.

Efficiency in Beginning Reading: Possible Effects on Later Comprehension

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No controversy in the field of reading is as pervasive as that surrounding the problem of the most efficient methods for teaching decoding. Most of the discussion has centered around the relative merits of "look-say" and phonics. The arguments concern which of these methods should be chosen, or at least which shall receive the greater emphasis. Perhaps the answers are wrong because the original question was inappropriate.

As a historical matter, we have proceeded from one choice of skill emphasis to another, proceeding successively in this century from a phonic approach to a look-say approach to a fairly recent use of context clues. It has been recognized in recent years that dependence upon any one single strategy for decoding may be inadequate. In some classes, children are taught more than one decoding strategy. If one strategy does not work, the child is told, try another decoding strategy. This practice of providing a choice of strategies is certainly superior to giving a child only a single strategy, but has a serious flaw, which will be explained later.

LIMITATIONS OF INDIVIDUAL STRATEGIES

Phonics as a single procedure has some well-known problems. First, the English orthographic system in many cases gives a relatively minimal indication of the pronunciation of a given word. Probably all spellings can be termed as "regular" if one investigates their structure and derivation sufficiently, but a first grader cannot, of course, be expected to have all of this knowledge. A second problem is that there are numerous homographs in the English writing system. Phonics gives no clue as to whether a *ball* is an object to be used in playing a game or whether it is a dance.

The meanings of words can be identified with precision only in the contexts in which they occur. Thus, context is an essential clue to precise decoding. However, it still is true that *black* and *white* or *yes* and *no* can serve interchangeable semantic and syntactic functions, with context alone giving the reader no indication of which is the correct choice.

Dependence upon a look-say or configuration-clues approach entails the memorization of words through repetition. The problem for initial reading is that this gives no help in the decoding of unknown words.

Finally, there are those practices which are apparently helpful in beginning reading, but which may actually hinder mature reading. For instance, one may learn certain phonic procedures for "sounding out" large numbers of words and may therefore appear to be a very successful beginning reader. However, this same sounding-out procedure is an extremely slow, inefficient barrier to comprehension when it is used as the means of attacking each word that is met. As a result of this practice it is not uncommon that primary grade teachers are considered to be very competent because of the apparent success of their students, but intermediate grade teachers find that the children are not successful in "content areas," a direct result of the "successful" instruction which was used in the primary grades. Through habit, the reader uses mediating processes for the recognition of each word--processes which should long since have become unnecessary and which are stumbling blocks rather than aids (Smith, 1971).

A COMBINATION OF STRATEGIES

From the preceding discussion, it should be clear that words cannot be successfully decoded with the use of a single decoding strategy. As shown above, the practice of using any single strategy leaves too much opportunity for error. The only procedure that can essentially eliminate possibilities for error is the use of combined strategies (K.S. Smith, 1973). As noted earlier, the use of a choice of strategies is an improvement over dependence upon a single decoding strategy. Nevertheless, the choice-of-strategies approach still leaves an unacceptable margin for error since a child merely tries one strategy, then another, rather than using them in combination. In a sentence such as "We played a game of _____," there might be a considerable range of words consistent with the semantic and syntactic context. The unknown word might be tennis, pool, basketball, football, baseball, etc. If however, we note that the first letter is a *t*, then the only possible choice from those given is tennis. If, of course, the initial letter is *b*, then further graphic information would have to be utilized. However, it would be inefficient to use more graphic information than necessary in order to be certain that one had made the correct choice. If this sounds like a guessing game, it is, but it's guessing with corroborative data (Freeman, 1973; Goodman, 1968, 1976A, 1976B).

In a study conducted with college students to determine the amount of accuracy attainable through the use of context in combination with various graphic clues, we used children's books in grades one to eight from a variety of content areas. We deleted every seventh word, thus providing the reader with some 86 percent known words, and then asked students to fill in the blanks. It was not our purpose, at this point, to determine how well children use such information. Rather, it was our purpose to determine *the extent to which such information was available in the text.*

The table on page 58 shows that with first grade materials, one can achieve at least 96.1 percent accuracy through the use of only the initial consonant in combination with context. This percentage drops off as the choice of words becomes greater in the higher grades. Nonetheless, one can achieve a "word identification" accuracy level of approximately 80 percent or better through the use of only context and the initial letter for the whole first-through-eighth-grade range of materials used in this study.

This does not, of course, imply that skills beyond the use of context and the initial consonant or vowel be ignored, instead place the emphasis in beginning reading on those strategies that yield the greatest efficiency. If, as argued earlier, it is the case that the meanings of words can be precisely identified only in the contexts in which they occur, then it becomes clear that the use of context in combination with the initial consonant is sufficient for accuracy in decoding in the overwhelming majority of cases. Furthermore, with this combination-of-strategies approach, a child is trained to use the graphic information necessary for the elimination of error, rather than trained to laboriously sound out words unnecessarily. It is, therefore, suggested that children be trained in kindergarten and first grade in the use of context on an oral/aural plane. Some materials useful for this purpose are Holt, Rinehart and Winston's *Kinder Owl* and *Little Owl* series, and most of children's poetry. As a child begins to read, his earlier oral/aural training in the use of context will enable him to feel comfortable with the use of context for decoding, and as soon as he learns some initial consonants, he can begin to use a combination of strategies.

Table 1

Story Title & Grade Level	*Initial Letter Only*	*Initial Consonant Only*	*Initial Consonant or Cluster*	*Initial Consonant or Cluster or Vowel*	*Initial Consonant or Vowel & Last Letter*
Susan & the Telephone (1)	92.5%	96.1%	98.2%	97.8%	100%
Fish for Dinner (1)	94.0%		91.3%		
Susan Bear-skin (3)	90.9%	85.4%		89.7%	95.8%
Light-houses (3)			82.8%		95.2%
Picture Visit to FBI (6)			69.5%		85.8%
Thief of Silver Spring (6)	79.2%	72.3%	78.2%	75.1%	84.1%
Inventions (7-8)	84.2%	76.5%			
British Isles (7-8)	84.5%	73.6%			

Percentage of Accuracy in Decoding Modified Cloze Passages

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